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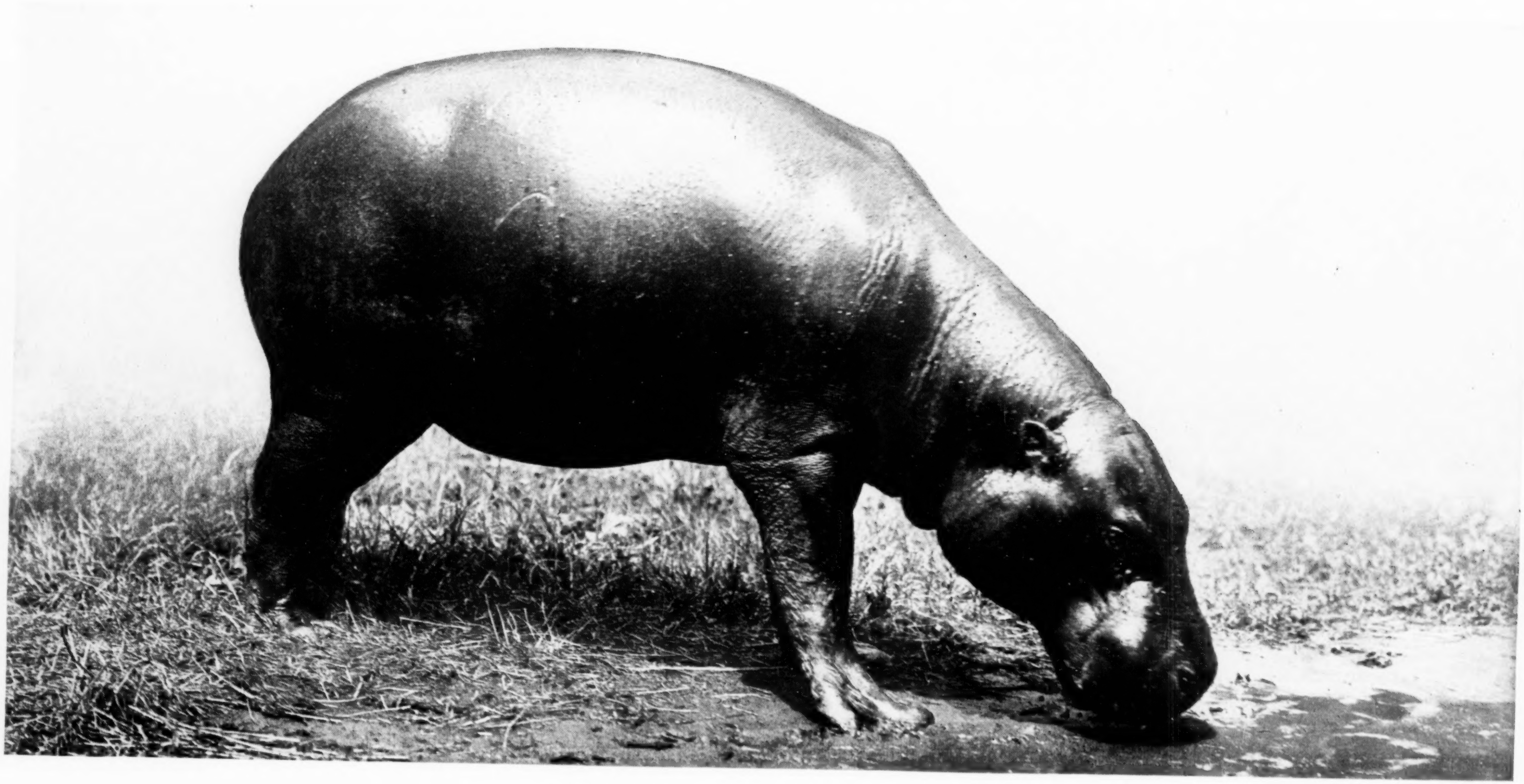


PIGMY HIPPOPOTAMUS OF LIBERIA.

The animal, when full grown, weighs less than 500 pounds, and stands only 30 inches high at the shoulder. He is, therefore, easily restrained by fences, and would not offer the problem of control, if domesticated, that would be furnished by the larger hippopotami, which would scorn any ordinary barrier As the meat is good, it is believed that this pigmy hippopotamus, in the swamps of the gulf states, might furnish a large quantity of meat with very slight cost of production. (Frontispiece.)

[See "Meat Production in Swamps," page 34.]

HOW TO IMPROVE THE RACE

Success Possible, but not by Processes Employed with Lower Animals—Little Gain from Preventing Marriage of Undesirables — Important Point Is Formation of a Prepotent, Desirable Stock by Marriages of Desirable People with Each Other — This Prepotent Stock Will Then Raise the Level of the Great Bulk of Normals.

ALEXANDER GRAHAM BELL, *Washington, D. C.*

LIVING organisms have proven so plastic in the hands of scientific breeders that we have learned to improve our breeds of plants and animals by suitable selection controlled by man.

Human beings, also, are undoubtedly capable of modification by selection; but it is manifestly impossible to apply to them the processes employed with the lower animals.

The difficulties of the problem may perhaps be appreciated if we consider for a moment how far it would be possible to improve our breeds of domestic animals under the conditions which prevail among human beings.

Given, for example, a flock of sheep to be improved, but under human conditions.

First, we must not butcher any of the animals. Ovine life is to be considered as sacred as human life. We must not mutilate the animals; nor do anything to them that is inconsistent with the humanitarian spirit of the age.

The weaklings are to be preserved and given special care. In fact, all of the animals, including the poor little deformed lambs, are to be kept alive as long as possible. They are to be treated with kindness and consideration until they die of old age, or from other causes beyond our control.

To these condit ons we may add the following: polygamous unions must not be permitted; nor unions between individuals related in various ways.

A man, for example, may not marry his grandmother; nor his mother; nor his sister; nor his daughter; and if we apply all the human restrictions to sheep, we shall have our hands full indeed in merely examining the ancestry of the flock, and the relationships of the individuals to one another, so as to avoid the prohibited unions.

While we are forbidden to allow certain classes of unions, we are not permitted to select the individuals that should be mated together to improve the stock. Each individual of the flock, under the restrictions referred to, must be free to choose its own mate; and the pairing shall be for life.

We may confidently assert that under such conditions no scientific breeder would undertake to improve the flock,—it would not be possible.

THE HUMAN PROBLEM.

But these are the conditions we must face in attempting to improve our own race; and we may as well recognize, first as last, that we have no power to compel improvement.

A gleam of hope, however, appears in this connection when we realize that there is one great and fundamental difference between a community of human beings, and a flock or herd of animals: The individuals of the human community possess intelligence.

The individuals have power to improve the race, but not the knowledge of what to do. We students of genetics possess the knowledge but not the power; and the great hope lies in the dissemination of our knowledge among the people at large.

Another important difference between human beings and the lower animals, arising from intelligence, is that human beings give some thought

to their unborn progeny. All desire that their offspring may be of the best; and no one wishes to have degenerate or defective children.

The attitude of the public mind is therefore favorable to voluntary compliance with plans which appeal to the intelligence of the community as reasonable and right; and favorable to the formation of a public opinion which will compel compliance.

These are such hopeful conditions that they will bear recapitulation.

The members of a human community, both individually and collectively, desire that their descendants may, if possible, be better than themselves.

They possess intelligence to understand the laws of heredity as applicable to man; and a willingness to adopt any reasonable and practicable measures that may be formulated for the benefit of future generations.

All recognize the fact that the laws of heredity which apply to animals also apply to man; and that therefore the breeder of animals is fitted to guide public opinion on questions relating to human heredity. Without power to control, he has power to advise; and the public generally will accept his statements as sound, because based upon special knowledge and experience in the breeding of animals.

What an opportunity for the members of the American Genetic Association to benefit the human race! Most of the disputed questions of human heredity can be settled by them, and their verdict will be acquiesced in by the general public.

Statistics relating to the effect of inbreeding among animals, for example, could surely be made to guide public opinion rightly on the subject of consanguineous marriages among human beings.

So, too, statistics relating to the effect upon the offspring of maturity and immaturity in the parents of animals, would seem to have a bearing upon the question of early *versus* late marriages among human beings.

The first thing for us to do, is to make known to the public the processes that are needed to improve the race; and then to show how, by intelligent cooperation among the members of the community, these processes may be applied.

IMPROVING RACIAL STATURE.

In considering the question of improvement, it may be well to begin by taking some specific quality of an inheritable nature and examining its distribution among the population at large.

Take stature as an example. We have pigmy races of men, and it is quite conceivable that some such race might deem it desirable to increase the general height of the population.

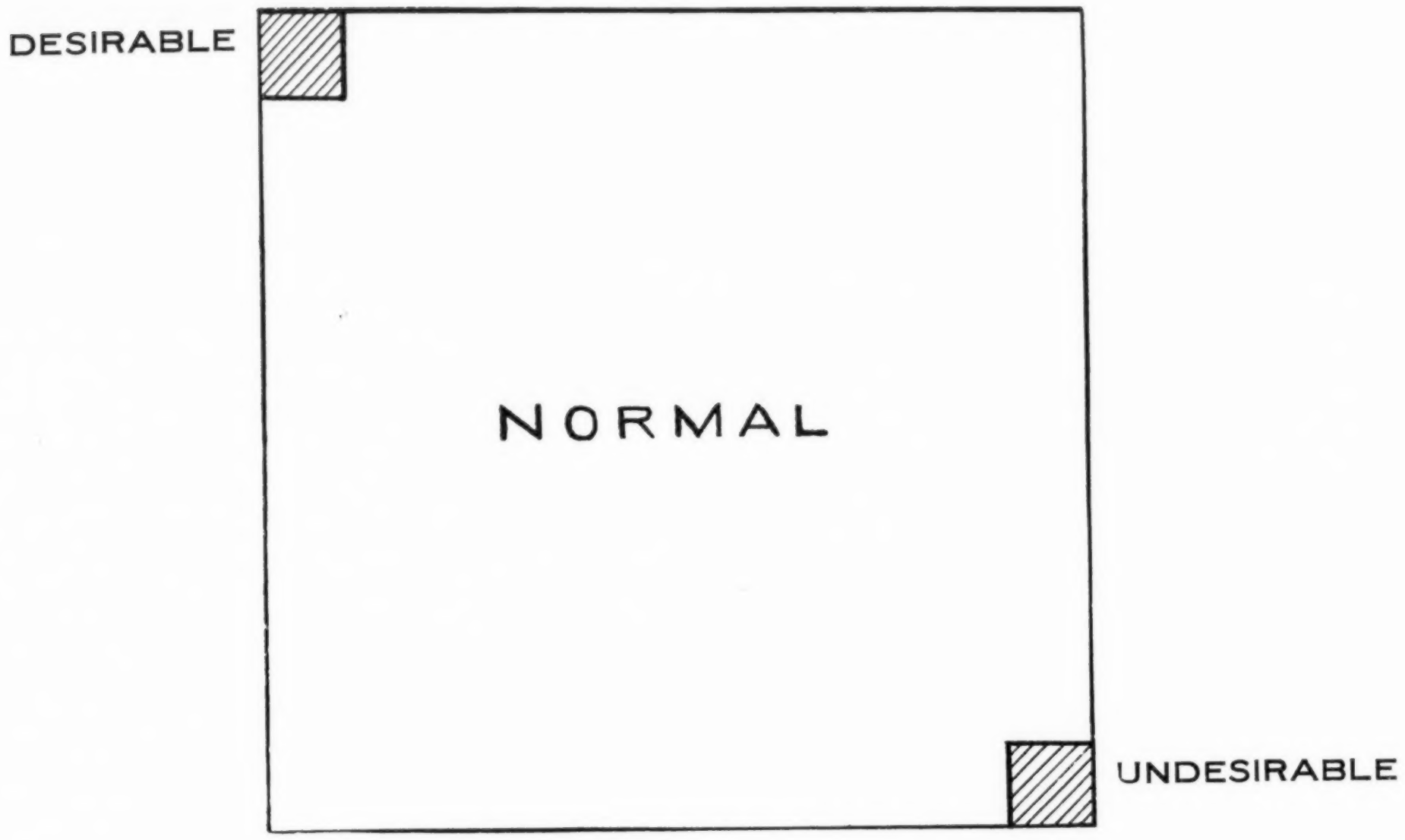
The members of the race all possess the desirable characteristic (height), but in varying degrees; and upon this variability depends the possibility of improvement. The difference between the extremes shows the amplitude of the variation; and if we sort out the population in accordance with the degree in which they possess the quality, we shall find a continuous series from the lowest to the highest. Some intermediate point represents the average degree in which the quality is possessed by the race.

The people who are markedly above the average height will, in this case, constitute the desirable class; and those who are markedly under the average would be the undesirable.

We are accustomed to focus our attention so exclusively upon the desirable and undesirable classes that we are apt to forget that there is an intermediate class, the normal, which is many times greater than both of the others put together, constituting, indeed, the bulk of the population.

The accompanying diagram may perhaps be of assistance in realizing the relative proportions of these classes. Let the large square represent an enclosure completely filled with the people under consideration. The square then represents by its area the whole population to be improved in height.

Now if we look the people over, we shall find here and there exceptional individuals who stand well above the general level. Collect them together



THE MAKE-UP OF THE HUMAN RACE.

In discussions of eugenics, the relatively small part of the population made up by the superior and the inferior is sometimes allowed to occupy so prominent a place that we forget that the great bulk of the race is made up of normal people, as the diagram clearly shows. Mr. Bell points out that because of this overwhelming numerical preponderance of the normal people, the easiest, quickest and most natural method of raising the level of the whole race is to raise the level of this huge mass of normals, instead of devoting all our attention to reducing the relatively insignificant number of inferiors.

into a pen in one corner of the enclosure. These constitute the desirable class represented by the small shaded square at the top of the diagram, which expresses, by its area, the number of tall people found.

In a similar manner, collect the markedly undersized individuals, and place them in a separate pen represented by the shaded square in the lower corner of the diagram. These constitute the undesirable class.

The rest of the population, occupying the unshaded portion of the large square, are normal people of somewhat about the average height.

Stature is convenient as a typical illustration because in this case the desirable quality, height, is capable of measurement.

APPLICATION UNIVERSAL.

If, however, any other inheritable quality be taken as an illustration, the people can, in a similar manner, be sorted out into the three classes shown in the diagram:

1. The great normal class possessing the quality in a normal or average degree.

2. The desirable class, possessing the quality in a markedly greater degree than the average.

3. The undesirable class, possessing it in a markedly less degree than the average.

On the scale shown in the diagram the desirable and undesirable classes each constitute 1% of the population and the normal 98%. Whatever may be the actual relative proportions, the diagram expresses the undoubted fact that the normal class constitutes the bulk of the population; and that the desirable and undesirable classes are very small as compared with the normal.

In the case considered the people generally have been of small stature as far back as their history extends. There has been no substantial change in the average height of the race within historical times. From this we may conclude that the ancestors of the present generation were mainly of the present normal height; and that only a few of them were much taller or shorter than this.

The above diagram, then, represents substantially the relative proportions of the three classes at each successive generation of the population. It typifies the future distribution, as well as the past, unless some means can be found to change it.

The desirable and undesirable classes, like the normal, are sprung mainly from normal parents; so that it is obvious that no process of interference with the marriages of these classes could much affect the relative proportions of the three classes in the next generation of the community. If, for example, the desirables and undesirables should all decide to lead celibate lives so as to leave no descendants, we would have just about as large a proportion of desirables and undesirables in the next generation of the community, born from the normal class.

SELECTION IN MARRIAGE.

The individuals belonging to the desirable and undesirable classes are not only few in number, but are scattered throughout the community. They appear only here and there as exceptional cases, and are not segregated from the others in their actual distribution in the population. If, then, they decide to marry, it is obvious that most of the desirable and undesirable individuals will marry normal persons, because normal people constitute the bulk of the community with whom they come in contact; and the offspring will tend to revert to the normal type of the race. From this it follows that, on the whole, the offspring of the desirables will be less desirable than themselves; and the offspring of the undesirables more desirable; most of the offspring will be of the normal type.

Given a large normal class, and two small classes, the desirable and undesirable, the problem is, how to increase the proportion of desirable children born from the normal population.

This can be accomplished by marriage with members of the desirable class.

In the typical case considered, this would mean that persons of normal height would increase their liability to have tall children by marrying tall people.

> Where normals marry normals a small proportion (say 1%) of the offspring will belong to the desirable class.
>
> Where normals marry desirables the percentage of desirable offspring will be increased (say to 10%).

Of course, it is only possible for a small proportion of the normal population to marry persons belonging to the desirable class, on account of limited numbers. The range of choice, however, may be extended by marriages with brothers or sisters or close blood relatives of desirable persons. That is upon the assumption that we are here dealing with an inherited characteristic.

PROOF OF INHERITANCE.

The late Professor W. K. Brooks, of Johns Hopkins University, said:[1]

"An inherited characteristic may, or may not, have been manifested by the parents or other ancestors. . . . If it is more common either among the ancestors or the brothers and sisters and cousins of the organism than it is in the race at large, this fact is scientific proof that it is an inherited characteristic."

Where a peculiarity manifests itself in only one member of a family we are dealing with a sporadic case; and the peculiarity may, or may not, be transmitted to the descendants: But where a number of people in the same family exhibit the same congenital peculiarity we have good reason to believe that it

[1] See appendix to Rep. Royal Comm. on Blind, Deaf and Dumb, etc., London, 1889, ii, 322; also Education of Deaf Children, Pt. II, p. 104, Volta Bureau, Washington, D. C., 1892.

is an inherited characteristic, and therefore liable to be handed down to some of the descendants by any member of the family, even by those members who do not exhibit the peculiarity in their own persons.

These considerations lead us to the conclusion that persons of normal height will increase their liability to have tall offspring by marrying into families containing a number of tall persons. In such a family the tendency to produce tall people is evidently an inherited characteristic; and the normal and undersized members of the family, as well as the taller members, will have a tendency to transmit the characteristic to some of their descendants. The tendency is in the blood, and the whole family possesses it.

INFLUENCE OF ANCESTRY.

In this connection the influence of ancestry is most marked:

(1). Where Normals (whose ancestors on the whole were normal people) marry Desirables (whose ancestors were chiefly normal), the normal partners will prove prepotent over the desirable partners in affecting the offspring. The bulk of the offspring will be normal; and only a small proportion (say 10%) desirable.

(2). But where Normals (with normal ancestry) marry Desirables (whose parents were desirable) the proportion of desirable offspring will be increased (say 20% desirable). The potency of the desirable partner to have desirable children is practically doubled, because of inheritance from both parents; and the prepotency of the normal partner is correspondingly reduced.

(3). Where Normals (with normal ancestors) marry Desirables (whose grandparents as well as parents were desirable) the proportion of desirable offspring will be still further increased (say to 45%); and the prepotency of the normal partners will be reduced almost to zero.

(4). Where Normals (with normal ancestry) marry Desirables (whose ancestors for several generations back were all desirable) it is the desirable partner who becomes prepotent over the normal partner in affecting the offspring. The vast majority (say 90%) will be desirable.

The influence of the normal partner will be less and less according to the number of desirable ancestors possessed by the desirable partner. With a sufficient number of generations of desirable ancestors, the desirable partner is what is known as "thoroughbred" in respect to the inherited characteristic. The normal partners, on the other hand, are not usually thoroughbreds for the normal condition; for if we examine their ancestors for the same number of generations back, we shall find, as a rule, that some of the ancestors were not normal: Some few were desirable, and some few even undesirable.

THOROUGHBREDS PREPOTENT.

We breeders are familiar with the prepotency of the thoroughbred animal over the normal animal; and we can therefore confidently assert that the human throughbred will be equally prepotent over the normal human being in affecting the offspring.

In spite of the smallness of the desirable class, its influence in improving the normal population would be considerable should it contain a number of highly prepotent individuals: For their marriages with normal people would result in the production of offspring almost exclusively of the desirable type (say 90 per cent. desirable). We should also remember that the brothers and sisters of the prepotent individuals will also have a strong tendency to produce desirable offspring where they marry normals with normal ancestry.

The liability of normal persons to have desirable offspring will be increased by marriages with persons of the desirable class; and diminished by marriages with undesirables.

In the latter case the proportion of *undesirable* children will be increased and if the undesirable partner is descended from undesirable ancestors the proportion of undesirable children will be still further increased.

The establishment of even a small

body of prepotent individuals within the undesirable class would exert a considerable harmful influence, because their marriages with normal persons would result chiefly in the production of undesirable children.

UPSETTING THE EQUILIBRIUM.

In considering the influence of marriage in affecting the distribution of the three classes in the next generation of the community, we may notice that in general the marriages of normals tend to keep things just as they are. That is, they tend to produce a large class of normals and two small classes of desirables and undesirables, in just about the same relative proportions as in the preceding generation.

The marriages of the desirables, on the whole, tend to raise the average of desirability in the community; and the marriages of the undesirables tend to lower it. The desirables pull the average upwards, the undesirables pull it downwards; and when these upward and downward tendencies are just equal they neutralize one another and a static condition prevails: The race as a whole neither advances nor recedes.

If the potency of the desirable class to produce desirable children is greater than the potency of the undesirable class to produce undesirable children, then we have a case of unstable equilibrium, and the whole race begins to move upwards.

Conversely, if the potency of the undesirable element is greater than that of the desirable element, then the race begins to move downwards.

Thus, it is the *difference* between the potencies of the desirable and undesirable classes that controls and determines the amount and direction of the racial movement.

If, then, we wish to improve the race the aim should be *to increase the potency of the desirable class to produce desirable children;* and this can be accomplished by promoting the marriages of the desirable with one another.

The moment we have a body of desirable persons *whose parents were also desirable*, improvement of the race begins through the marriage of such persons with the normal population: for the proportion of desirable offspring born from the normal partners will be greater than in cases where the desirable partner had no ancestors belonging to the desirable class.

The improvement will be still greater when we have a body of desirable persons who had grandparents as well as parents desirable; and still greater with each increase in the number of desirable ancestors.

Thus, the simple process of promoting the marriages of the desirable with the desirable will, through the mixture of the descendants with the rest of the population, inaugurate an improvement of the whole race; and the movement will advance with accelerated velocity as we have more and more potent individuals of the desirable class. This process continued through a number of successive generations would ultimately result in the establishment of a prepotent stock within the desirable class, and then the improvement would be very marked indeed.

CHIEF OBJECT OF EUGENICS.

Here it is to be noted that the elevating tendency is due to the desirable class alone; and that improvement depends upon *increasing the number and proportion of desirables born in successive generations of the population*. Hence, this should be the chief object of eugenics; and it is to be regretted that the efforts of eugenists have been mainly directed to the diminution of the undesirable class.

So much has this been the case that the very word "eugenics" is suggestive to most minds of hereditary diseases and objectionable abnormalities; and of an attempt to interfere, by compulsory means, with the marriages of the defective and undesirable. This relates to cacogenics ("badly born") rather than to eugenics ("well born").

The utmost that could be even hoped for from such a process would be to lessen the tendency to retrogression and degeneration; and even this result would not be attained, at least in any great degree, for the simple reason that

the undesirables, as a rule, are descended from normal parents.

Prohibition of marriage would not, therefore, have much effect upon the continued production of an undesirable class. We would have just about as many undesirable people appear in the next generation, *born from the normal population.*

Then again, the tendency to reversion to the normal type of the race is so strong that the children of undesirables are mainly of the normal type; so that prohibition of marriage would prevent the production of very many more normal children than undesirable children.

Whatever processes may be employed to improve the race, we shall always have the undesirable with us, because they are sprung mainly from the normal class; and *it is more practicable to improve the undesirable strains than to eradicate them.*

If undesirables marry normal or desirable partners they will not only have fewer undesirable children than if they married one another, but the potency of the offspring to produce undesirable grandchildren will be reduced. The undesirable blood is diluted, so to speak, by admixture with normal blood; and most of the offspring will be of the normal type.

CONCLUSION.

A public sentiment already exists that persons possessing inherited characteristics of a desirable kind should marry and have large families. This sentiment undoubtedly is favorable to the improvement of the race; but it does not go far enough.

We should impress upon the public the point that one certain means of increasing the prevalence of any hereditary characteristic in a community is to induce the individuals who possess it *to marry one another;* and thus produce a more potent stock in the next generation.

It is neither practicable nor advisable that the individuals referred to should marry exclusively among themselves, but only to a much greater extent than now prevails; and the public policy should be: Promote the marriages of the desirable with one another.

Selection by Birth-Rate

The eugenist recognizes that selection is essential to the progressive improvement of the human race, but he seeks to substitute a selective birth-rate for the selective death-rate which has been the cruel instrument used by nature.—W. C. Marshall, in the Eugenics Review.

Need of Eugenic Education

Recent investigations point with no uncertain hand to degeneracy rather than racial progress as the probable result of our existing social system. How then is this danger to be averted? The social reformer has long been busy in his attempts to improve the environment of the people; and his efforts merit our warmest approval. Progress in the evolutionary sense is, however, not certainly thus promoted, and may not be promoted at all. What we also need is an intellectual campaign, which will make the path of eugenic reform stand out more clearly in front of us by increasing our knowledge of the laws of heredity; and a moral campaign to make our fellow countrymen now ready to accept the sacrifices necessary to insure the racial progress of their country in the future.—Extract from presidential address (1913) of Major Leonard Darwin before The Eugenic Education Society, London.

THE CHESTNUT BARK DISEASE

An Undesirable Immigrant Which Has Secured Firm Foothold in Eastern United States—Breeding Resistant Species Probably the Only Solution of Problem—Opportunity for Orchardists On Pacific Coast to Build Up Industry.

HAVEN METCALF

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IN A remote part of northeastern China, in the province of Chili, east of the Great Chinese Wall, and four or five days' journey by bullock cart from Peking, there is a little-known section of mountainous country. Here a species of chestnut, the exact identity of which is not yet known, but which may possibly be *Castanea mollissima*, grows wild on the mountain slopes and valleys and is also cultivated by the Chinese for its nuts (fig.1). These chestnut trees have a disease which in appearance is somewhat like the European apple canker, as it occurs in America on apple trees. So far as we know it does relatively little harm to the chestnut trees of China, simply producing permanent cankers on some of them, killing a few limbs, and probably occasionally killing young trees. There is no reason to suppose that the Chinese ever had any clear cognizance of it as an especially harmful agent, and it does not appear to be conspicuous enough to have attracted the attention of even the observing traveler, until it was discovered this summer by Frank N. Meyer, of the United States Department of Agriculture. Probably it is not more conspicious than certain canker diseases of junipers in America, which have only recently been recognized and described.

It would seem at first thought that such a condition, occurring in an unknown corner of the Orient, was about as remotely connected with any practical interest in this country as the complexion of the Grand Lama. But the world is rapidly becoming a small place, and obscure facts of natural history in one remote section may become of profound significance on the other side of the globe, affecting property, health, and even life. The disease above referred to is what we now know as the Chestnut Bark Disease, and is caused by the fungus *Endothia parasitica*. This parasitic fungus appears to have been unwittingly introduced into this country, probably in the 90's or late 80's, and to have been distributed to various points in chestnut nursery stock. The parasite found the American sweet chestnut a wonderfully susceptible host, and has spread and assumed characters on this tree which, so far as we know, are wholly unparalleled in its native habitat. There were possibly many importations of this disease. Its early history in this country is obscure, and will probably always remain so. By 1903 or 1904 it was in full blast in the vicinity of New York City, and its subsequent spread is authentic history. There were other old centers, but the vicinity of New York City appears to be the oldest.

ITS DISTRIBUTION

The disease is now generally distributed in native chestnuts from Merrimack County, N. H., and Warren County, N. Y., on the north, to Albemarle County, Va., on the south. In New York the western border of distribution is sharply delimited by an area without chestnut trees—a natural "immune zone"—which extends southward along the eastern borders of Fulton, Montgomery, and Schoharie Counties nearly to the Pennsylvania line in Delaware County. Consequently, in New York the range of the disease is at present practically limited to the valley of the Hudson. In Pennsylvania the western limit of general infection is roughly along a curved line extending

A CHESTNUT GROVE IN CHINA.

The Chinese chestnut (*Castanea mollissima*) has been cultivated for centuries by the Chinese horticulturists. This photograph, sent in by Frank N. Meyer, agricultural explorer of the United States Department of Agriculture, shows the low-branching, open-headed habit of the species. Scars on the trunks caused by attacks of the bark disease can be seen plainly. Near San tun ying, province of Chili, June 1, 1913. (Figure 1.)

from the northwest corner of Susquehanna County to the eastern border of Clearfield County and on to the southwest corner of Fulton County. West of this line the advance infections were cut out by the Pennsylvania Chestnut Tree Blight Commission. The disease has not yet been found in Ohio or Indiana. In general it appears to spread northeastward and southwestward, following the direction of the ridges of the Appalachians, much more rapidly than westward, across the ridges and valleys.

Scattering infections occur outside of this area. Of these, the outposts are two infections on planted chestnuts in Franklin and Androscoggin Counties, Maine, and one infection in a nursery in North Carolina. There is reason to suppose that the North Carolina infection, and an orchard infection in British Columbia, owe their origin to trees imported directly from the Orient. The disease has not yet been reported from Europe, but its appearance there must be only a question of time.

It is difficult to estimate the financial loss which the above distribution represents, as we have no exact statistics on the value of standing chestnut timber. The estimate of $25,000,000 made in 1911 as representing the loss up to that time was probably much too conservative. But the total loss to date is insignificant compared with the loss which will ensue when the disease attacks the virgin chestnut timber of the South Appalachians. The bark disease has killed all the chestnut trees in those localities where it has been present long enough, and there is not now the slightest indication that it is decreasing in virulence or that the climate of any region to which it has spread is having any appreciable retarding effect upon it. Insects which eat the pustules of the

AMERICAN CHESTNUT ATTACKED.

This and the four following figures, showing stages in the progress of the bark disease, were taken by Professor J. F. Collins at various points on Long Island. This photograph shows where the disease has secured a foothold on some of the smaller limbs, which are quickly killed. When the infection is on the smaller limbs, however, the rest of the tree may survive for several years. (Figure 2.)

parasite have been considered as possible retarding agents, but as these same insects appear to also distribute the spores, their controlling influence is not likely to prove important.

MANNER OF INFECTION

When, in the Chinese chestnut, any spores of the parasitic fungus gain entrance into a wound on any part of the trunk or limbs, they give rise to a canker which persists on the tree, becoming deeper year by year as healthy wood is formed around it. In the American chestnut, however, the canker rapidly enlarges until it girdles the tree. If the part attacked happens to be the trunk, the whole tree is killed, sometimes in as short a time as a single season. If the smaller branches are attacked, only those portions beyond the point of attack are killed, and the remainder of the tree may survive for several years. Ultimately, however, all American chestnut trees that are attacked, die completely (fig. 5). Figures 2, 3, and 4 show the typically ragged appearance of such trees, due to the fact that some branches are not yet girdled and still have normal foliage, while others are dead.

Limbs and trunks with smooth bark soon show cankers in the form of dead, discolored, sunken areas, which continue to enlarge and become covered more or less thickly with the yellow, orange, or reddish brown pustules of the fruiting fungus (figs. 6 and 7). From these pustules masses of minute spores (conidia) are commonly extruded

SECOND STAGE OF THE DISEASE.

One after another, the limbs are invaded by the parasitic spores, and quickly succumb. A peculiar ragged appearance in the tree is produced, due to the fact that many branches have not yet been girdled by the fungus, and therefore retain their normal foliage. When the canker begins in the trunk, it rapidly extends until it girdles the whole tree, and death quickly results. (Figure 3.)

in the form of long, irregularly twisted strings or horns (fig. 6), which are at first bright yellow to greenish yellow, or even buff, becoming darker with age. If the canker is on the trunk or a large limb with very thick bark there is no obvious change in the external appearance of the bark itself, but the pustules show in the cracks (fig. 7), and the bark often sounds hollow when tapped. After the limbs or trunks are girdled the fungus continues to grow extensively through the dead bark, sometimes, if conditions of moisture are favorable, covering the entire surface with the reddish brown pustules (fig. 7). These pustules produce mostly the type of spores called ascospores. If the proper conditions of moisture are present the fungus may grow on the bark of chestnut logs and even upon bare wood.

When a branch or trunk is girdled the leaves beyond change color and sooner or later wither (figs. 2, 3, 4, and 8). These prematurely killed leaves often remain on the branches, forming, together with the persistent burs, the most conspicuous winter symptom of the disease (fig. 8). Suspicion has been recently aroused in some quarters that the dwarfed and abortive nuts in these burs may under some circumstances be unwholesome, or even poisonous, when eaten. So far, however, the evidence on this point is wholly inconclusive.

CONSPICUOUS SYMPTOMS.

The most conspicuous symptom at all times of the year is the occurrence of sprouts at the base of the tree, on the

THIRD STAGE OF THE DISEASE.

Most of the limbs have been killed, although the withered leaves may remain on them for some time afterward, and the bark may show few external symptoms of the disease. Sprouts are put out thickly at the base of the tree and in various parts of the top where there is still vitality. Any burs produced are dwarfed, but there is no evidence to prove that nuts from them are poisonous. (Figure 4.)

trunk, or on the branches (figs. 2, 3, and 4). Sprouts may appear below every canker on a tree, and there are often many such cankers. These sprouts are usually very luxuriant and quick growing, but rarely survive their third year, as they in turn are killed by the fungus. The age of the oldest sprout, as determined by the number of its annual rings, is an indication of the minimum age of the canker immediately above. The annual development of sprouts from the base of a tree has been observed to continue for at least seven years after the death of the tree. If infection of these basal sprouts could be prevented, they would develop into a much better type of coppice than is usually seen, since they are well rooted in the ground. After the tree is dead the dead sprouts on the trunk, together with the scars left by cankers on the outer layers of wood, serve to show what killed the tree long after the bark has completely decayed and fallen away.

The wood is not materially injured, and may be used for all timber purposes for which healthy trees might be used, provided the diseased trees do not stand so long after they are dead that they become sap-rotted and checked. This fact greatly facilitates the prompt destruction of diseased trees, which will do much to check the rapid spread of the disease, and in localities where such work is organized under State control, as in Virginia and West Virginia, may limit it entirely. If the course of the disease is not thus checked by human effort, the complete destruction of the present stand of chestnut is a practical certainty. This will be

FINAL STAGE OF THE DISEASE.

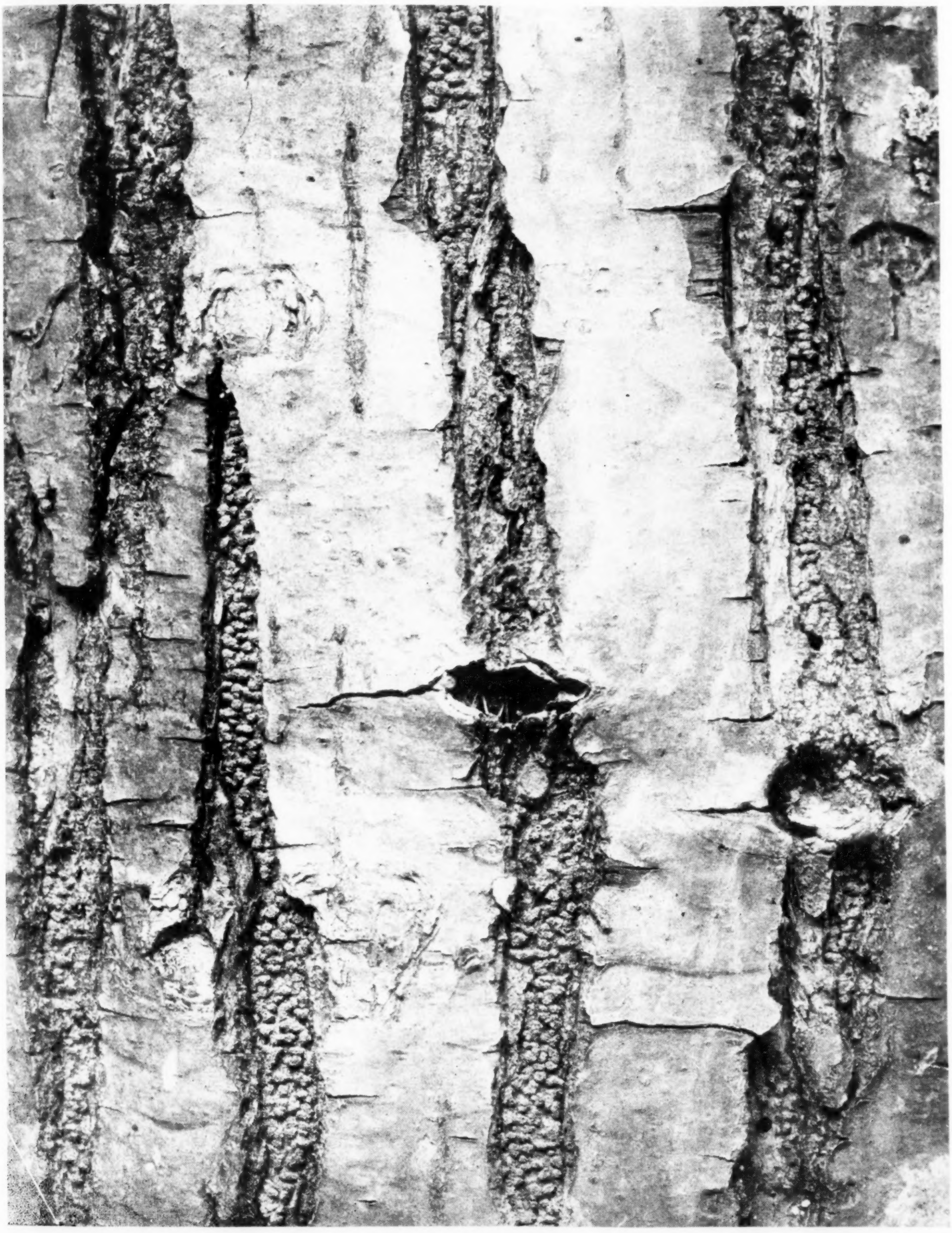
The entire tree finally succumbs, often within two or three years after the first infection. The wood is not materially injured for timber purposes, but great care must be used in disposing of it, that the spores are not carried into new regions and set free on trees which have not previously been attacked. (Figure. 5)

followed by a struggle between the fungus and the sprouts from the roots of the killed trees. In this struggle the marvelous regenerative power of the chestnut may enable it finally to overcome its subtle antagonist, but so far little hope of this can be held out from observation. Hundreds of chestnut trees have been under the writer's close observation since 1907, and although some have produced a new crop of sprouts each year since that time, the sprouts have rarely passed their second year without becoming diseased, or their third year without being girdled. North of the Potomac River the main problem now is how to dispose most profitably of the timber of the dead and dying trees. In Southern New England the proposition has already been made on distinguished authority, to replace the disappearing chestnut stand as rapidly as possible with white pine.

As has been indicated, diseased chestnut nursery stock has been the most important factor in the spread of the bark disease. On account of the well-grounded fear of this disease much less chestnut nursery stock is being moved now than formerly, but there is still enough to constitute a serious source of danger. It is therefore obvious that every State in which the chestnut grows, either naturally or under cultivation, should as speedily as possible pass a law putting the chestnut bark disease on the same footing as other pernicious diseases and insect pests, such as peach yellows and the San Jose scale, against which quarantine measures are now taken. Many inspectors already have the legal power

"SUMMER SPORES" OF THE FUNGUS.

These strings or "horns" of conidia are extruded from the pustules of the fruiting fungus on all the cankered limbs. At first the conidia are bright yellow or greenish yellow, but they gradually turn darker with age. These conidia are by no means always present, however, and in some cases, as in young nursery stock, it is exceedingly difficult for anyone except an expert to detect the presence of the fungus. (Figure 6.)



PUSTULES IN CRACKS OF BARK.

When the pustule attacks a large limb or the trunk, there is little obvious change in the external appearance of the bark itself, but the pustules show in the cracks of the bark, as can be clearly seen in this photograph. The bark often sounds hollow when tapped. The fungus continues to grow after the trunk is girdled, sometimes covering the entire surface with reddish-brown pustules, which produce the type of spores called ascospores. (Figure 7.)

to quarantine against the bark disease on chestnut nursery stock, and they should now take special care that no shipment, however small, escapes their rigid inspection.

A PRACTICAL DIFFICULTY.

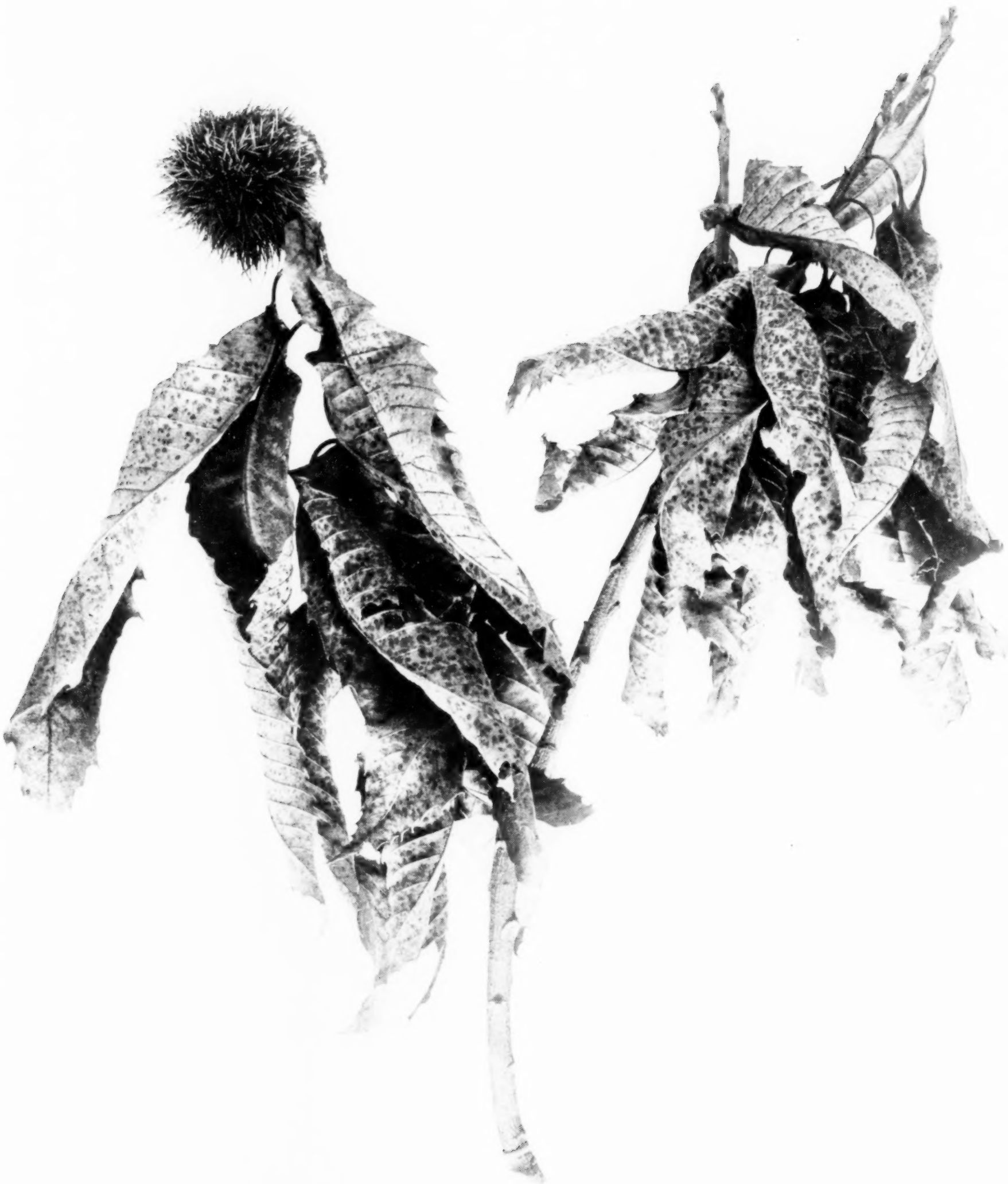
The most serious practical difficulty in inspecting nursery stock for this, as for other fungous diseases, lies in the fact that virtually all State inspectors are entomologists and are usually not trained in recognizing the more obscure symptoms of fungous disease. Nursery trees affected by the bark disease rarely show it prominently at the time when they are shipped; the threads of conidia or the yellow or orange pustules are rarely present, and usually all the inspector can find is a small, slightly depressed, dark-colored area of dead bark, usually near the ground, which is easily overlooked or mistaken for some insignificant injury. Upon cutting into such a spot the inner bark shows a most characteristic, disorganized, "punky" appearance and characteristic "fans" of the yellow mycelium of the fungus. Occasionally a very characteristic yellowish brown or reddish band or blotch, either girdling or partly girdling the young tree, may be seen.

If infected trees are set out they develop the disease with its characteristic symptoms the following spring. On account of their small size such trees are girdled and die before the end of the summer. Meanwhile they become a source of danger to neighboring orchard and forest trees. Orchardists and nurserymen purchasing chestnut trees are therefore urged to watch them closely during the first season, no matter how rigidly they may have been inspected.

In view of the uncertain future of the chestnut tree the planting of chestnuts anywhere east of Indiana, at least for the present, can hardly be advised. West of the natural range of the American chestnut, however, the situation is quite different. Obviously the western chestnut orchardist has before him a great opportunity. No matter how successful efforts to limit the bark disease may be, the nut crop will be reduced for some years, and the business of growing fine orchard chestnuts in the East will be depressed for the same length of time. There is no apparent reason why, with rigid inspection of purchased stock and of the orchards themselves, all chestnut orchards and nurseries from Indiana to the Pacific coast can not be kept permanently free from the bark disease; therefore, all persons interested in growing the chestnut in the West are earnestly advised to be sure that stock from any source is rigidly inspected, to watch continually and with the utmost care their own nurseries and orchards, and to destroy immediately by fire any trees that may be found diseased. The discovery of an infected orchard in British Columbia indicates that other chestnut orchards will probably be found on the Pacific coast which have become infected by direct importation from the Orient.

BREEDING NECESSARY.

Probably the most practical control results in the long run will be obtained by the breeding and propagation of varieties of chestnut that are immune or highly resistant to the bark disease. Elsewhere in this magazine Dr. W. Van Fleet has described his work in this line. It appears that so far no immune or even resistant individuals of the American chestnut have been found, in spite of strenuous search; so that we must largely depend on the Asiatic varieties. The slight resistance of the chinquapin, as observed in the field, may be due only to its comparative freedom from bark insects. The species of Chinese chestnut upon which the disease occurs in China (fig. 1) is apparently resistant to the disease in that climate, but it remains to be seen to what extent this resistance will persist when the trees are grown in America. The Japanese chestnut is highly resistant, and certain strains apparently immune; these strains form at present the most hopeful basis for breeding. At present we do not know exactly what the Japanese chestnut is; most of the trees that pass under this name in the American market appear to be hybrids with the American or other varieties.



DWARFED LEAVES AND BUR.

These are borne on a branch girdled by the bark disease. It has been widely reported that eating nuts from such burs produced symptoms of poisoning in human beings, and also that cases of poisoning had occured when squirrels which had fed on such nuts were eaten. There is not evidence, however, to prove either of these suppositions. These persistent, dwarfed burs with their abortive nuts are the most conspicious winter symptom of the disease. (Figure 8.)

All of the Asiatic varieties of chestnut so far known are small trees and probably slow growing. The Chinese chestnut, or at least the variety shown in figure 1, bears nuts that are about the size of the American chestnut, or a trifle larger, and of a delicate, sweet flavor and fine texture. The Japanese varieties are also small trees and in general have large, coarse nuts, with a bitter adherent inner skin; but there appear to be some strains that are sweet. No European varieties have yet been found that are appreciably resistant. Perhaps the greatest desideratum at this time is a resistant tree of the forest type. But this may yet be found, as the world-species of Castanea are not yet assembled.

How much easier it would have been, and how much loss could have been avoided if importation of nursery stock had been safeguarded in time to have excluded this latest addition to our collection of foreign diseases and pests. Prevention is cheaper than cure; this is the first great lesson to be learned from the invasion of the chestnut bark disease. It is too late to exclude this undesirable citizen; but we can at least redouble our efforts to see that no others get a foothold on this continent.

Inheritance of Milk Yield

Inheritance of the property of milk production in a registered herd of cows in East Prussia is discussed by J. Peters in Nos. 11, 12 and 13 of the Deutsche Landwirtschaftliche Tierzucht, Hannover, Germany, 1913. His data show great variations in the inheritance of milk yield. The offspring of the best mothers yielded, on the average, the most milk and those of the inferior mothers least. The range of variation was not, however, so great among daughters as among mothers. First class cows produced both good and inferior offspring, and *vice versa*. The inheritance varied around a center, which was somewhat higher in the daughters of superior mothers than in those of inferior cows. The magnitude of the variation was the same for all classes.

Peters then determined the milk production of the grandparents and of the separate families of the herd. With regard to the families, he found that some produced relatively many good animals, while the descendants of others were usually inferior cows; in other families, again, he observed unusually large variations in the performance of the offspring. As a rule, however, the offspring of good families were good milkers and those of inferior families unsatisfactory. Inheritance varied in the case of mediocre families.

The writer comes to the conclusion that it is not sufficient to estimate the absolute and relative yield of cows, and upon these data to select the offspring of the best *individual* performers for further breeding, but it is necessary to select the *best families*, for among the descendants of these will be found the largest number of good milch cows. His data are summarized in the Bulletin of the International Agricultural Institute, Rome.

The Improvement of the Human Race

The improvement of the breed of mankind is no insuperable difficulty. If everybody were to agree on the improvement of the race of man being a matter of the very utmost importance, and if the theory of the hereditary transmission of qualities in man was as thoroughly understood as it is in the case of our domestic animals, I see no absurdity in supposing that, in some way or other, the improvement would be carried into effect.—Francis Galton, in Macmillan's Magazine (1865).

CHESTNUT BREEDING EXPERIENCE

How the American Chestnut, Threatened by Extinction, May Be Saved to Horticulture, Even if not to Forestry—Promising Crosses Between Chinquapin and Asiatic Species—Trees Bear Early, Produce Good Nuts and Show Resistance to Blight.

WALTER VAN FLEET

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THE advent about twenty years ago of certain large-fruited and early-bearing chestnut varieties of the European and Asiatic types, some appearing to be natural hybrids between the exotic species and our native sweet chestnut, *Castanea americana*, suggested to the writer the possibility of breeding all accessible species of the genus in a systematic manner. Between the years 1894 and 1911 many careful pollinations of the native species, including the bush or Virginia chinquapin, *C. pumila*, were made, using the European and Asiatic varieties then obtainable. Some cross-breeding within the species for the purpose of improving quality of nuts and accentuating the early bearing propensities of the Japan and European types was also attempted. The result of these undertakings have been successful, in the main. The appearance in 1907 among our plantings of the terribly destructive new bark disease organism, *Endothia parasitica*, put a summary termination to the experiments with *C. americana* and its derivatives, but selection work has since continued with self- and chance-pollinated individuals of the chinquapin and Asiatic types.

The method pursued in hybridizing was carefully to cut away, as they appeared, all traces of the male catkins or aments and to enclose the selected branches as soon as pistillate blooms were visible in roomy paper bags which were kept on except during pollination until the stigmas withered. The chinquapin crosses were made on a particularly productive and precocious plant grown from seeds collected in Virginia in 1889. The entire bush was systematically emasculated each flowering season, every branch being gone over daily, so that no pollen whatever was liberated, and protection from wind and insect-borne foreign pollen was further assured by covering the bush during bloom with a cheese-cloth tent in addition to the paper bags on separate branches. Pollen was secured by gathering catkins in early morning from desired species and varieties and allowing the anthers to dehisce in a sunny window protected from flying insects of all kinds. Applications to the stigmatic surfaces were made by means of the brush, finger tip, and by flicking or lightly drawing the catkins over the stigmas where pollen could be plainly seen coating the anthers. All these methods proved measurably successful but the latter gave, on the whole, the best results.

HYBRIDS PRECOCIOUS

About thirty per cent. of these controlled pollinations produced viable seeds and practically all the seedlings grown—over two hundred in number—showed unmistakable evidence of hybridity. Nearly all have fruited, the chinquapin-Asiatic crosses often bearing nuts the third year of growth, while the combinations of Asiatic and European chestnuts with our native species rarely set burs until five to twelve years old. The cross-bred Japan varieties show greatest precocity, frequently blooming and occasionally ripening nuts the second year after germination, and in a few instances producing several pounds of nuts the following season, three years after planting the seeds.

A VIGOROUS HYBRID CHESTNUT

The second generation, four years old from self-pollinated seed, of a hybrid between the American chinquapin (*Castanea pumila*) and the Japanese chestnut (*Castanea crenata*). In addition to its blight resistance, the hybrid is valuable because it ripens its nuts early in the year. (Figure 9.)

A HYBRID CHINQUAPIN

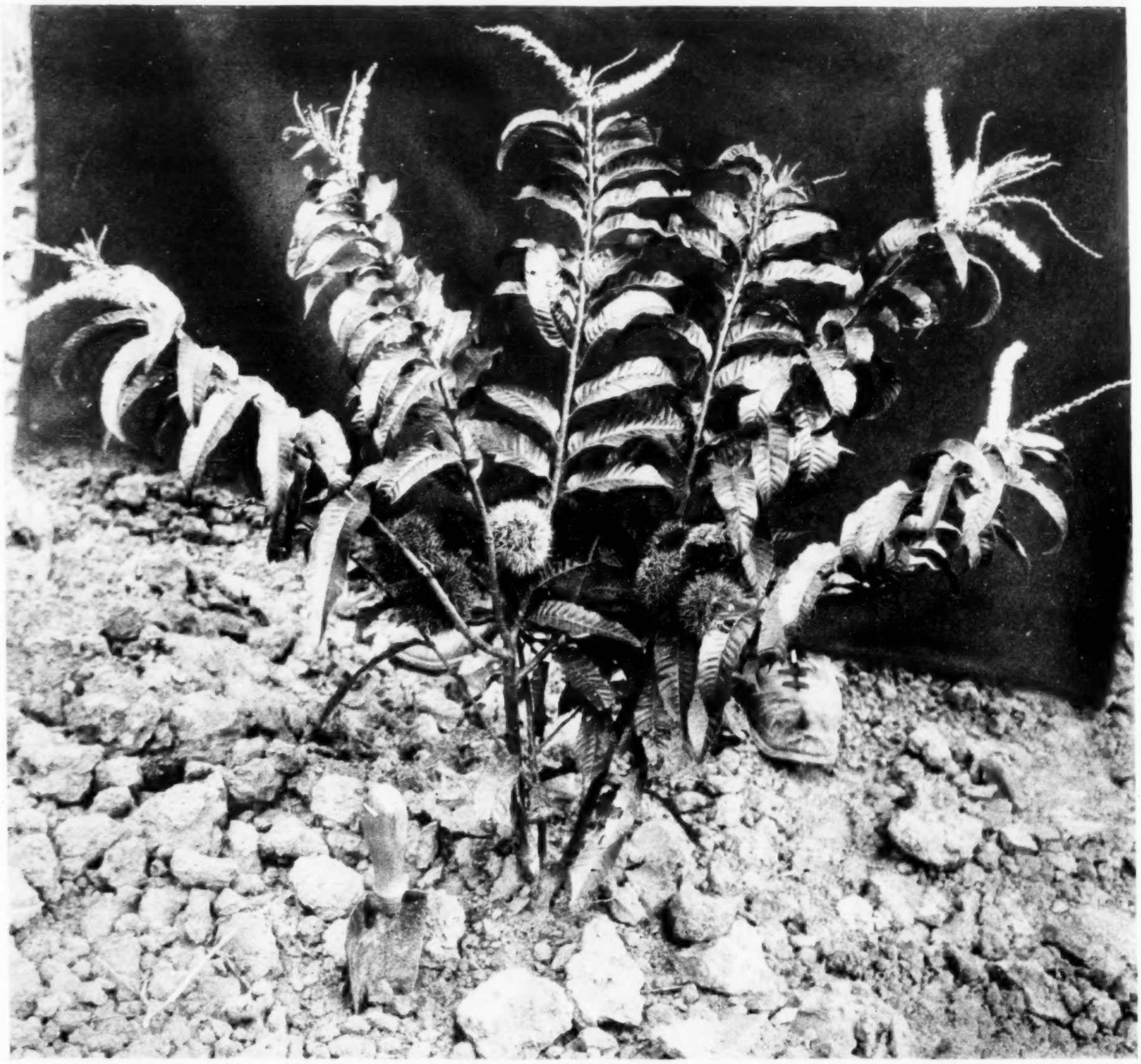
These nuts are produced by a seedling which was grown from the cross between the shrubby American chinquapin and the Japanese chestnut. Three nuts are usually borne in each bur, and they are larger in size than those produced by any of the native American species. Photograph natural size. (Figure 10)

The bark disease has been allowed to work its will among the hybrids with the result that trees having *C. americana* in any combination have nearly all disappeared. Seedlings of Paragon chestnut, the best variety of the European type, pollinated with our native species, attained an average height of twenty-five feet and were bearing excellent nuts when attacked in 1910, but all have succumbed. The crosses of Asiatic and native, fewer in number, showed greater resistance but all have been seriously affected. The chinquapin-European hybrids are readily affected but have great recuperative powers, bearing nuts the second year on suckers springing from the bases of diseased stems. Chinquapin-native crosses, with the exception of the Rush chinquapin—a probable natural hybrid found wild in Pennsylvania—appear very susceptible and do not as readily recover. The wild chinquapin itself appears measurably resistant, several individuals, including two Rush chinquapins, thriving for years with no signs of disease though constantly surrounded by infection.

The Asiatic chestnuts, and the chinquapin-Asiatic hybrids, are plainly highly resistant. Few have shown any appearance of infection and when noticeable the injury is quite local in character. Second generation seedlings of chinquapin-crenata crosses show no disease at all though always exposed to infection.

QUALITIES OF HYBRIDS

The material results of this breeding work, other than the disease-resisting features, are shown in the various illustrations accompanying this article. Hybrid chinquapins having varieties of *Castanea crenata* for the pollen parent form vigorous, small, much branched trees, rarely shrubs, and come into



A FOURTH-GENERATION TREE.

This cross-bred Japanese chestnut (*Castanea crenata*) is only twenty-three months old from seed, but is blooming and bearing ripening nuts at the same time. Trees with this pedigree usually flower the second season, showing greater precocity than any others with which experiments have been made; in a few instances they have produced several pounds of nuts in the third season after the seed was planted. (Figure 11.)

bearing at three to five years from the seed. They bloom profusely, bearing long chestnut-like catkins as shown in plate 11. The burs are borne like chinquapins in clusters or racemes of three to five or more, rarely solitary, and contain from one to three chestnut-like nuts four to six times larger than chinquapins.

Nuts of the various species and types, freshly collected and without selection as to size, averaged in weight as follows:

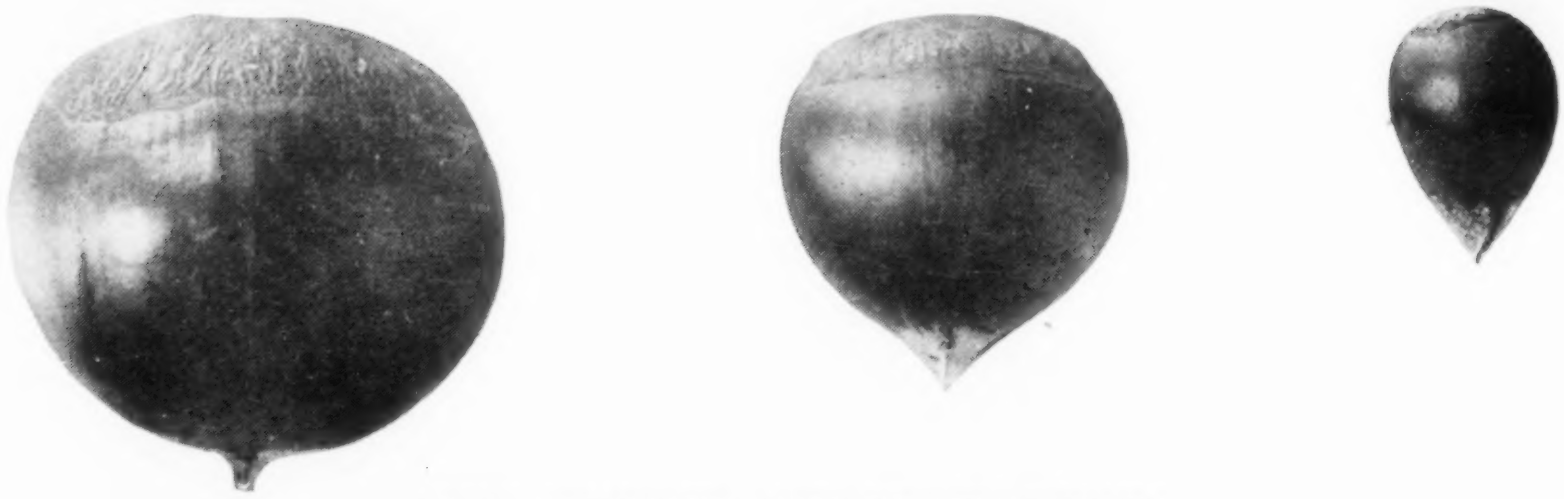
100 nuts	Chinquapin	100	grammes
" "	Native Chestnut	395	"
" "	Hybrid Chinquapins	613	"
" "	Japan Chestnut (pollen parent)	1024	"

The first second-generation hybrid to fruit in quantity bears nuts weighing 416 grammes to the hundred. They show a tendency to increase in size and weight as the tree develops. The appearance and relative sizes of the various nuts are well shown in the accompanying plates.

The time of ripening is very early, forestalling even the wild chinquapin, as the first burs open late in August, the crop being wholly mature by October without frost, thus preceding all other chestnuts of marketable size. The nuts are handsome in appearance, smooth, dark brown in color, with very slight tomentum, and as they possess

TWO WILD CHESTNUTS AND A HYBRID.

In the center is the hybrid produced by a cross of the wild American chinquapin (*Castanea pumila*) and the Japanese chestnut (*C. crenata*). At the left is the ordinary American chestnut (*C. americana*) as produced in forests. At the right is the wild American chinquapin (*C. pumila*), which is valuable in crosses because of its vigor and adaptability to the climate, although its nuts are too small to be of great value, as produced by wild trees. Photograph natural size. (Figure 12.)



THE HYBRID AND ITS PARENTS

In the center is one of the first nuts produced by the cross between the wild American chinquapin (shown at the right) and the Japanese chestnut at the left. The nuts of the hybrid are midway in size between those of its parents, but in maturity and blight resistant qualities, it seems to combine all the good characteristics of both ancestors. Photograph natural size. (Figure 13.)

thicker shells than chestnuts, they keep their fine appearance under exposure much longer. The quality appears to vary slightly according to the immediate pollen parent, but is quite comparable to that of our best wild chestnuts—not quite as sweet as the little wild chinquapins, but good enough when cured to be enjoyed thoroughly without cooking. There are none of the starchy and tannin-like flavors so common with the larger European and Asiatic chestnuts and no hint of bitterness in the inner skin as with the immediate pollen parents.

TREES ARE VALUABLE.

The trees are vigorous growers, decorative from their compact form at all times, but especially so when in fruit and flower. They should prove highly desirable for lawn planting as well as for nut growing. The size they would ultimately attain, if continuously free from disease, is problematical. The tallest is about nine feet high and eight in spread of branches at nine years from but the seed, was once transplanted under retarding circumstances. Their precocity and profusion in fruiting would indicate that the trees are not likely to attain large dimensions and that it would be safe to plant them for orchard purposes at least as near together as peach trees—say twelve to fifteen feet apart. Propagation of particular varieties has not yet been attempted, but it is to be expected that they may readily be grafted on seedling chinquapins or resistant stocks of the Asiatic types.

It is to seedlings of these hybrids, however, that we may reasonably look for greater variation than is likely to be had from direct hybridization of the species. The germination percentage of the hybrid nuts is rather low—there appears frequently a poor connection between the embryo and the endosperm—but about half produce vigorous seedlings with very diverse foliage, resembling beech, oak and holly leaves rather than chestnuts in the juvenile stages. By the second year the foliage segregates into the chinquapin type with slight, light tomentum on the under surfaces and that of the chestnut, larger and clear green on both sides, accompanied with the characteristic branching of the respective types.

The pollen parents of the best chinquapin hybrids, with few exceptions, were home raised varieties of *C. crenata* and quite likely are themselves hybrids with our native chestnut, as the two species are believed to interersoss readily when grown near together. The slight susceptibility of the chinquapin hybrids to the bark disease—not greater, certainly than that of the Keiffer pear to the bacterial pear blight—can thus readily be explained. The breeding of selected chinquapins with pure Asiatics, particularly of the Chinese forms that are thought to be highly resistant, might afford even better results than have yet been secured in regard to this feature.

A very promising Chinese chestnut, already given the provisional name of *Castanea mollissima*, is now being established through the efforts of the Office of Foreign Seed and Plant Introduction, and will soon be available for breeding purposes. While scarcely a timber tree as compared with our native species, it is nevertheless of good dimensions and apparently a quick and thrifty grower. The nuts are of really excellent quality, though of only medium size, and are said to be produced freely at a comparatively early age. The especially promising quality, however, is a marked resistance, as demonstrated by experimental inoculations that have so far caused little harm, to the Endothia disease.

Chestnut breeding, though greatly hampered by the advent of the new disease, thus makes its appeal as a highly promising occupation. It appears probable that the chestnut in its most desirable form can be saved to horticulture as a nut producer if not to forestry as a profitable timber tree, and there is even a chance that the latter highly important feature may in the end be spared.

The Origin of Species

How a three-horned species of bull (*Bos triceros*) "originated" in Senegambia and was accepted by the leading scientists of the world, is amusingly told by Th. Monod and G. Moussu in the Bulletin de la Soci´té Nationale d'Acclimatation de France, 15 September, 1913. The species was first announced by the distinguished zoologist de Quatrefages, in the name of Dr. de Rochebrune, in 1880.

In 1885 Dr. de Rochebrune discussed the possible origin of this third horn, which was on the face of the animals. He decided that it was a typical specific characteristic, and his opinion has always been accepted.

It now appears that this horn is merely the result of an inoculation which has been practiced upon many of the cattle of Senegambia since 1864, as a preventive against peripneumonia. An incision is made in the face of the animal and serum injected; the resulting inflammation causes the appearance of a bony projection covered by a horny mass, which has outwardly the appearance of a true third horn. A dissection at once shows, however, that it is merely an excretion.

It will be necessary, then, for students to scratch *Bos triceros* off the list.

An Explanation of Graft-Hybrids

M. Lucien Daniel has made a communication to the "Academie des Sciences" from which it appears that the anatomical examination of grafts of Helianthus on Helianthus and of Opuntia on various cacti has revealed to him the existence of internal adventitious roots formed in the stock and penetrating to various depths in its tissues. Occasionally these roots even reach the soil and bestow complete independence on the graft. M. Daniel considers this to be the probable explanation of certain cases of hybridization through grafting—Journ. Soc. Nat. Hort. Fr., June, 1912, quoted in Journ., R. H. S., Aug., 1913.

Galton's View of Eugenics

I take Eugenics very seriously, feeling that its principles ought to become one of the dominant motives in a civilized nation, much as if they were one of its religious tenets.—Francis Galton.

The Scope of Eugenics

Charity refers to the individual; Statesmanship to the nation; Eugenics cares for both.—Francis Galton.

CHESTNUT BLIGHT RESISTANCE

Castanea Alnifolia and C. Mollissima Show No Signs of Blight—American Chinquapin Seems Almost Equally Vigorous—Japanese Varieties Usually Succumb—Experiments Prove Nuts Develop Freely When Female Flowers Are Not Pollinated.

ROBERT T. MORRIS, M. D., *New York, N. Y.*

EIGHT years ago, when the chestnut blight (*Endothia parasitica*) began seriously to menace my native chestnut forest, situated in the towns of Stamford and Greenwich, Conn., notes were made upon the subject and a number of varieties and species of chestnuts were added to the collection. At that time there were about five thousand old American chestnut trees (*Castanea americana*) upon my country place; there were also half a dozen chinquapins (*Castanea pumila*) about five years of age, and a few grafted trees of named varieties of chestnuts which had been purchased from nurserymen at about the time when the chinquapins were purchased. There were two saplings of *Castanea mollissima*, the Chinese chestnut, which had been given me by Professor C. S. Sargent.

None of these notes in relation to ages of trees and numbers of trees, which follow, are quite scientifically accurate, because as a busy man with many kinds of responsibilities, the matter of records has been left to employees. Changes in the meantime have taken place among the employees. I am writing from memory, rather than from notes, when making this contribution.

When it became evident that the American chestnut trees on my place were seriously menaced, the question of finding blight-resisting individuals among species and varieties came up, and I proceeded to add to the collection various species and varieties until it included twenty-six different kinds. Among these kinds, species were as follows: American sweet chestnut (*Castanea americana*), bush chinquapin (*Castanea pumila*), tree chinquapin (*Castanea pumila arboriformis*), alder-leaf chestnut (*Castanea alnifolia*), evergreen chestnut (*Castanopsis chrysophylla* or *C. sempervirens*—I do not know which species). In addition to these American species of chestnut there were two specimens of *Castanea mollissima*, and many specimens of species not determined by me, from England, France, Italy, China, Korea and Japan. There were also a number of grafted varieties of descendants from European and Asiatic progenitors.

PROGRESS OF DISEASE.

The fate of these chestnuts may be briefly summed up at the present time about as follows:—

The evergreen chestnuts (*Castanopsis*) which I set out on several different occasions, were always eaten during the winter or spring by cattle or by rodents, on account of their attractive green leaves and tender shoots above the snow, notwithstanding various attempts at protection.

Every one of the five thousand old American chestnut trees became blighted, and they were removed. Younger trees and stump shoots of the American chestnut are now practically all dead or dying with the blight.

Various grafted varieties of European and Asiatic chestnuts have shown

GIANT CHESTNUT IN EASTERN CHINA.

Although the bark disease is found in the groves of this region, the Chinese species (*C. mollissima*) seems to have acquired a high degree of immunity to it. This photograph, taken at San tun ying, province of Chili, shows scars on the tree, where the disease has made its appearance but been overcome. A large number of seeds of trees of this species have recently been introduced by the department of agriculture and distributed among investigators in the United States. (Figure 14.)

different degrees of resistance to the blight. Some of them which show an occasional blighted limb may be preserved with a moderate degree of care. This is also true of the seedlings of European and Asiatic varieties. None of them appear to be as vulnerable as the American chestnut, but most of mine are dead nevertheless.

Korean chestnuts and chestnuts from the Aomori region in Japan resisted the blight almost completely until they were six years of age. Since that time they have shown a marked tendency to blight, but resist it better than does the American chestnut.

Korean and Japanese chestnuts when grafted upon American chestnut sprouts all blighted in their second or third year after grafting while their "parents" remained unblighted, indicating that the sap of the American chestnut furnishes attractive pabulum for Endothia. American chestnuts grafted upon stocks of Korean and northern Japanese chestnuts showed a marked tendency to blight promptly, near the point of union of the graft, while the stocks remained unblighted.

One hybrid between the American sweet chestnut and the chinquapin blighted when about eight years of age and is now dead.

None of the American species of chinquapin, varying from five years to about thirteen years of age, has blighted, with the exception of two limbs, which were injured by falling limbs of a blighted American sweet chestnut tree. These injured and blighted branches were removed and there has been no other blight among the chinquapins.

TREE SCRAPED TO PREVENT DISEASE

The Chinese method of warding off attacks of the bark disease from their commercial plantations is to keep the trunk and larger limbs scraped clean, thus giving the spores of Endothia little foothold. This photograph illustrating the application of this crude method of prevention was taken at San tun ying, province of Chili, China, by Frank N. Myer, June 1, 1913. (Figure 15.)

Of the two which were injured one was a bush chinquapin and the other a tree chinquapin.

I purposely allowed dying American chestnuts to remain near the experimental test species and varieties in order to make the test severe. None of the specimens of *Castanea alnifolia* has blighted. None of the specimens of *Castanea mollissima* has blighted but these latter include only five trees—the two given me by Professor Sargent (now eight years old) and three received since that time from the Bureau of Plant Industry, Washington.

BREEDING EXPERIMENTS.

In order to breed hybrid chestnuts which would be resistant to blight, I made various combinations between staminate and pistillate flowers of *Castanea alnifolia*, *C. pumila* and *C. mollissima*. The most promising hybrid for timber purposes would presumably be one between *C. mollissima* and *C. pumila arboriformis*, but my tree chinquapins came into flowering this year for the first time. Next spring I shall make that combination. There are now growing in my collection various young hybrids between *C. mollissima*, *C. alnifolia* and *C. pumila;* likewise a number of other hybrid chestnuts, but these are at present from one to three years of age only and are of no value for data in reference to blight resistance.

When making hybrids between various species of chestnuts, I incidentally determined that parthenogenesis apparently occurs among the Castaneas. Three years ago a number of pistillate flowers of *Castanea pumila*, which had been covered with paper bags, were not pollenized for the reason that I did not happen to have pollen enough to go around. These paper bags were left in place unintentionally. Some three weeks later when they were removed because of unsightliness, the branches which had been covered with paper bags were found to have set full complements of nuts. These nuts went on to full development and were fertile—sprouting later. Some of them showed peculiar freaks. Cotyledons protruding through the involucre before the nuts were fully developed showed a trifle of chlorophyll coloration similar to that of the germ, which also protruded beyond the involucre. Another peculiar feature of the parthenogenic nuts was the disparity in size between shoots which grew from them in the following year, some becoming much larger and some remaining smaller than chinquapins growing from normal gametes. In order to make sure that no pollen had accidentally reached the pistillate flowers by way of insects or wind, carefully checked experiments were made in the following year, and so far as I can judge there is no doubt but the American chinquapin may develop its fruit freely by parthenogenesis or by formative budding from some cell.

Incidentally I may state that similar experiments were tried with *Juglans cinerea*, *Hicoria ovata*, *H. glabra*, and *H. minima*, and all of these apparently developed nuts by parthenogenesis, *Juglans cinerea* freely, and the three hickories sparingly.

The Supremacy of the Mind

We cannot raise the race by degrading individuals. Whatever lowers the humanity of fathers and mothers, whatever elevates the physiological above the psychological, the body above the mind, is an enemy of the race and no method for its regenerators.—C. W. Saleeby: The Methods of Race-Regeneration (1911).

The Biometric Standpoint

General theories of society are of no use, verbal discussions are of no use, philosophical reasoning is of no use. We need to observe, measure and record, to analyze by the methods of exact science, before we can advance in our sociology, before we can aid our working classes to a true insight of the factors which make for or mar our national vigor.—Karl Pearson: Nature and Nurture (1910).

EUGENICS AND BREEDING

Methods Used In Improvement of Plants and Animals Can Not Be Applied Directly to Improvement of Human Race, Since Object is Different—Diversity In Man To Be Encouraged—Cultivation of Eugenic Instinct More Important to Future of Race Than Weeding Out Defective Persons.

O. F. Cook,
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THERE is a popular idea that the human race is to be improved by a direct application of the methods of breeding that have given such valuable results in the improvement of plants and animals. It is unfortunate that this idea should gain currency, for a misleading impression of eugenic reform is conveyed. The difficulty of applying to mankind the same methods of breeding that are used with plants and animals has been considered by some writers as an obstacle to human progress, but in reality it would not be desirable to apply breeding methods to mankind, even if it were possible to do so.

The chief object of plant and animal breeding has been to secure uniformity, that is, to induce the expression of the same characters in all the members of a select group. In dealing with our domesticated plants and animals, uniformity represents the ideal condition of heredity because it means larger crops or a more valuable commercial product. Most of our boasted improvements of plants and animals are of this nature, and represent higher degrees of uniformity, rather than more advanced stages of evolutionary progress.

Nothing may be said of uniformity when breeders and fanciers are competing in the production of superlative, high-performance individuals, but everybody understands that the breeding value of a superior animal or plant depends upon its "transmitting power," meaning the regular appearance of the desirable characters in the descendants. A variety with a low average would not be popular even though it might produce occasional prize-winners. Plant breeders have taken uniformity most definitely into account, but the principle has been recognized for a longer period of time among animal breeders.

The development of an improved variety begins with the finding of a superior individual to serve as a parent. The skill of the breeder is shown in preserving the characters of this superior individual and developing a uniform race, all showing the same desirable characters as the select ancestor. Thus the art of breeding improved varieties is to substitute uniformity for diversity.

DIVERSITY IN NATURE.

Whenever we gain sufficient familiarity with a wild species or an unselected stock, a condition of individual diversity is found, like that with which we are familiar in the human species. It is this diversity that the breeder has learned to suppress. The method is to restrict descent to narrow lines, or even to a single parent, when self-fertilization or vegetative propagation can be practiced.

Viewed from this standpoint it is obvious that there is no agreement or even close analogy between breeding and eugenics. The objects of the two are almost diametrically opposed. The difficulty of applying the breeders' methods to the human race need not be considered as an obstacle to eugenic reform, because nobody would wish to parallel the breeders' results, so as to substitute for the present individually diversified human race a few uniform varieties composed of duplicate individuals.

Eugenic reform is not likely to attain very wide popularity if it is expected to result in a condition in which all the children of a family are to be as much alike as twins. Yet this is the ideal of the breeder, and the end that is attained by the application of the breeders' methods of improvement. Hence we may expect that a more adequate study of the problems of eugenics will lead to the development of methods altogether different from those that are in use among breeders of plants and animals. Progress must be made in eugenics without destroying or even seriously diminishing the normal individual diversity, that feature of human heredity with which we are most familiar.

A clear understanding of the nature, conditions, and causes of organic evolution is even more important for the eugenist than for the breeder. With the condition of individual diversity retained, the eugenic progress of mankind will have much more analogy with the normal evolutionary progress of wild species of plants and animals than with the breeding of uniform domesticated varieties. Too many writers on eugenics overlook the need of a broader and more truly biological point of view, and restrict their attention to the facts of heredity that have been learned from garden or laboratory experiments with domesticated forms.

The select strains that breeders develop from single superior individuals do not represent permanent steps in the evolution of the species, and often endure for only a few generations. New varieties are brought forward continually to take the places of those that drop out. Thus from the standpoint of the species, the breeder may be said to destroy the best individuals when he uses them as the parents of short-lived varieties. We are now beginning to appreciate the importance of preserving the wild, unselected types of our domesticated plants and animals, to serve as storehouses from which vigorous new varieties may be drawn as needed in the future.

ELIMINATION NOT ENOUGH.

In the conscious improvement of mankind the permanent interests of whole nations or races have to be considered instead of the formation of specialized short-lived varieties. It will not be sufficient to eliminate the conspicuously defective individuals as a plant breeder rogues out the "off" plants in attempting to preserve a variety from degeneration. Guarding the fertility of the best is a much more important issue than destroying or sterilizing the defectives. Galton's mastermind perceived this clearly enough, but many of his avowed followers have been impressed too much by the analogies of breeding.

If the objects and methods of eugenics are to be different, what have students of eugenics to learn from the breeding of plants and animals? The answer is that the same natural laws or relations seem to be manifested in the development of mankind as in the heredity and evolution of the lowest orders of plant and animal life. It is through the study of breeding that nearly all of our more definite knowledge of heredity has been gained in the past and that increase of such knowledge may be expected in the future. As far as eugenics is to be considered as a branch of biological science, it can not afford to neglect any facts or suggestions that may be developed in any other part of the biological field.

The time may come perhaps, when eugenics can be studied as a separate branch of heredity, without reference to the breeding of plants and animals, but for the present, and for many years in the future, the plants and animals must afford our best opportunities for gaining new experimental knowledge of heredity. It would be as far from the truth to suppose that the plants and animals can be neglected by eugenics as to suppose that the plant and animal methods can be applied directly to mankind.

The recently awakened interest in eugenics means that the future progress of humanity is to be aided by a conscious recognition of heredity as another chapter of the laws of nature that we must learn to obey. Thus far we have been content to float unconsciously, as it were, down the stream of life, feeling no creative responsibility for the future

of our race. Though often making much of our moral responsibility, and of the possibilities of attaining to some other existence after the life of this world, we have been accustomed to think of the future of mankind as something essentially beyond our control. That we have a biological responsibility for the generations that are to come is a new idea for our race. In this perception our wise men remained far behind the sages of ancient Greece, where racial improvement was recognized as one of the chief duties of patriotism.

IMPORTANCE OF HEREDITY.

But now we have begun to see that it may be possible, by taking thought of heredity, to navigate the stream of life with greater safety and avoid some of the whirlpools, rocks and quicksands which have destroyed our predecessors. And we see too that our race has reached the stage of development where civilization begins to be destructive, by interfering with the processes of natural selection that guide the progress and guard the strength of primitive peoples. Many forms of weakness and degeneration are arising and being preserved amongst us.

Yet the first stage of awakening to our eugenic responsibilities even brings new dangers. Anxiety to atone for past neglect and zeal of a new cause may lead eugenic reformers to attempt to seize the rudder before they learn what course to steer. This danger of premature interference with our social system on the ground of eugenic reform might be illustrated by many of the suggestions that are made along the line of direct application of animal breeding methods to mankind, not to speak of suggestions that are justified by nothing that we know of plant or animal breeding. Pity and prudence alike demand that useless suffering be avoided by reducing the proportion of deformed, defective or constitutionally diseased. However important this may be, it represents, after all, only the first or preliminary stage of eugenic responsibility and may even misrepresent the true objects and ideals of the eugenic movement. Sterilization of criminals and defectives would be one way to diminish the populations of prisons and asylums and thus reduce the taxes that future generations must pay, but to urge such measures on the ground of eugenics is like recommending house-cleaning as a substitute for architectual skill in building the houses. If our eugenic sensibilities were more highly developed the progress of the race would not be endangered by the propagation of defects and abnormalities.

The investigation of abnormal heredity can be described as eugenics only by way of contrast and precaution, and should not be allowed to displace the primary idea of eugenics as an investigation of the possibilities of constructive improvement of the race. It might be better if the study of hereditary defects in mankind were recognized as a separate branch of biological science under such a name as dysgenics or cacogenics, just as teratology is treated as a special branch of plant and animal morphology. Dysgenics would relate more properly to the study of defects as such, cacogenics to the production of the bad instead of the good, as when selection is reversed and the weak multiply instead of the strong.

EUGENICS NOT DYSGENICS.

Whatever the names, it is certainly most unfortunate to allow the general public to gain the idea that eugenics is a study of diseases and abnormalities. Yet this impression is frequently reflected in the public press and even in the comic journals. The middle-aged aunt is pictured as saying to the sweet girl graduate, "My dear, what a great deal of unpleasant knowledge you seem to have." "Yes, Auntie, but you know I've done a lot of work in eugenics."

Deformity, degeneration and disease are unpleasant ideas, but progress and perfectibility are not. The real question, of course, is not whether facts are pleasant, but whether we are giving attention to the important facts, those that will enlighten our judgment in dealing with eugenic problems. To dwell much upon the wrong facts may be worse than leaving the whole matter alone.

To specialize on the dysgenic features and leave the constructive eugenic ideas out of account is to neglect the most important lessons of organic evolution, as well as the best reasons for taking interest in eugenics. Higher appreciation of human nature in its normal perfection might be trusted to inspire the strongest motives of eugenic behavior, both in the individual and in the race. To develop eugenic perceptions and instincts is even more important than to magnify the idea of eugenic responsibility. There is no reason why eugenic appreciation of the perfection of human life should fall behind the artist's joy in painting pictures or carving ideal forms in stone.

Young men and women who prize life highly enough will not be tempted to choose weak, diseased or defective partners, or to take the risk of bringing crippled or weak-minded children into the world by marrying into families that have shown hereditary abnormalities. If our young people saw clearly and felt deeply that healthy, intelligent, affectionate children are the most precious of all possessions, they would perceive also the suicidal nature of dysgenic behavior. They would see that in disregarding the facts of heredity, now that the inheritance of defects is definitely known, they are forfeiting the right to the supreme happiness of life that normal children may bring. To the enlightened eugenic conscience it will be plain that the sins of the father are not visited on the children alone, but upon the parents as well.

More Knowledge Necessary

Except in very few cases, our knowledge of heredity in man is at present far too slight and uncertain to base legislation upon.—Professor R. P. Punnett, Cambridge University, England.

Eugenic Instinct Natural

The natural man and the natural woman are Eugenists at heart. Each of them prefers, in members of the opposite sex, youth and maturity rather than senility, beauty (which has a high degree of correlation with health) rather than ugliness, straightness and efficiency of limbs and feature rather than deformity, optimism rather than pessimism, intelligence, good temper, sympathy rather than their opposites. There is indeed, speaking in popular language, a eugenic sense; and the business of those who undertake the great task of education for parenthood is to educate—that is, to lead forth and develop—this sense, and, in the first place, to oppose and if possible destroy all those agencies, chiefly servants of mammon, by which the growth of this most precious element in our nature is vitiated or arrested. —C. W. Saleeby: The Methods of Race-Regeneration (1911).

MEAT PRODUCTION IN SWAMPS

Introduction of Pigmy Hippopotamus Offers Opportunity for Utilization of Large Areas in Southern States to Produce Excellent Meat at Low Cost—Difficulties of Securing Breeding Stock at Last Overcome.

WHILE most of the work of plant and animal breeders has, in the last analysis, the production of cheaper food by increasing the supply, as its object, there is one opportunity in the United States which has been entirely neglected. This lies in the large areas of swamp land in the southern states, which at present are economically almost worthless, and which cannot be reclaimed to ordinary agriculture except at great cost. If this land could be made directly useful in the production of meat, it would appear to be a desirable enterprise from every point of view.

Such a possibility was clearly outlined by the late W. N. Irwin, before members of the American Breeders' Association[1] several years ago, in a discussion of possible increase of meat production in the United States by the introduction of mammals not now found in this country. He remarked:

"In selecting other species for introduction, it is very important that we consider the food supply that they will require. We have several large areas well adapted to certain kinds of animal life, and not now producing, for the reason that the animals are not there. The area of greatest promise is in our gulf states, and consists of over 10,000 square miles (6,400,000 acres) of water and marsh surface, with a sufficient quantity of marsh grass, water hyacinths and other aquatic plants now growing to support thousands of animals adapted to those conditions. If properly seeded to water hyacinth and other aquatic plants, this vast region would be capable of producing a million tons of meat per annum, worth $100,000,000. This area should be stocked with hippopotamus (*Hippopotamus amphibius*), the flesh of which is highly esteemed, and when salted and cured, is known in the Cape of Good Hope as Zee-Koe Speck (lake-cow bacon). The fatty mass lying between the skin and the flesh or muscles is considered one of the purest of animal fats, and is in great demand among the cape colonists. These massive animals were to the English settlers in Cape Colony what the buffalo was to the pioneers in the settlement of our great prairies, and like the buffalo were almost heedlessly exterminated."

DIFFICULTIES PRESENTED,

Mr. Irwin's proposition never met with acceptance, as it was immediately pointed out that the hippopotami would be impossible to control. The introduction to the United States of the pigmy hippopotamus of Liberia, however, offers an animal that can be easily controlled and kept in fences, furnishes excellent meat, and may have a real economic future under such conditions as Mr. Irwin outlined.

This hippopotamus (*H. liberiensis*) is

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[1] Irwin, W. A. Animals that should be introduced and bred for economic and profitable meat production. A. B. A. annual report V, 214.

PAIR OF PIGMY HIPPOS IN NEW YORK PARK.

Although wild and difficult to capture, they have proved rather easily handled, and did not suffer from the hardships of transport from inland Liberia to the United States. Hans Schomburgck, the envoy of Carl Hagenbeck who secured these specimens, managed to tame a full-grown bull only a few days after he had captured it. (Figure 16.)

ignored in most scientific works[2], and to be found in few zoological parks. The New York Zoological Society now possesses three, however, which have aroused the interest of practical breeders as well as zoologists.

The adult male, supposed to be ten years old, is thirty inches high at the shoulders, seventy inches in length from end of nose to base of tail, with a tail twelve inches long. His weight is about 420 pounds. The female is believed to be only three years old, and when received (1912) stood eighteen inches high at the shoulders, weighing 176 pounds. The Director of the New York park, Dr. William T. Hornaday, describes them in the Zoological Society Bulletin (July, 1912) as follows:

"The Pygmy Hippo is characterized first of all by its midget size, which in the adult animal is about equal to that of a twelve-months-old baby hippo of the large species. Its skull is more convex, or rounded, on its upper surface, than that of *H. amphibius;* its legs are longer and more slender in proportion, and its eyes do not "pop" out of its head like those of the giant species. Another striking character is the long tail, which in proportion is about twice as long as that of its only living relative, *amphibius*.

"The face of the Pygmy is relatively

[2] The principal references are Proceedings of the Phila. Acad. Sci., Morton in 1844 and 1849, Leidy in 1852; and Zoo. Soc. Bull., N. Y., Hornaday and Schomburgck, xvi, 877, July, 1912.

smaller than that of the large species, which brings the eyes nearer to the median line of the skull. The lower jaw of the Pygmy bears only two incisor teeth, while the large species has four; and while the orbits of *liberiensis* are large, they are proportionally less elevated than those of the large hippo. As the latter swims nearly submerged, the eyes seem to float on the surface of the water like two shiny glass marbles.

"The color of the Pygmy is *recorded* as 'slaty black' on the back, sides greenish slaty gray, and under parts grayish white.

NOT TRULY AMPHIBIAN.

"We await with keen interest Hans Schomburgck's account of the habits, and life history in general, of this rare and strange animal. We have been informed, however, that it makes its home in swamps and wet forests, often at a distance of several miles from the nearest river or lake, and that it is not at all dependent upon large bodies of water, as its colossal relative always seems to be. We may confidently expect to hear that it subsists on fleshy and tender plants and reeds, and grass that is not too coarse and tough to be masticated by small jaws."

In the same issue of the Bulletin, the capture of these animals is described by Hans Schomburgck, Major and Military Attache of the Liberian Legation at London, who spent a year in Liberia securing these hippopotami for Carl Hagenbeck. His story forms an interesting chapter in the romance of zoological and botanical exploration.

"The greatest difficulty in hunting the Liberian Hippopotamus," he says, "is that, unlike their big cousins, they do not frequent the rivers. They make their home deep in the inhospitable forest, in the dense vegetation, on the banks of the small forest streams; but, not satisfied with the protection the forest affords them, they enlarge the hollows which the water has washed out under the banks, and in these tunnels, where they are invisible from the bank, they sleep during the heat of the day.

ANIMALS CAUGHT IN PITS.

"In spite of all difficulties, however, I had not given up the idea of catching a hippo alive. Wherever I found a likely place I had a pit dug. It is easy to catch the great East African Hippo, which keeps continually in the same water and uses the same tracks. With the Pygmy Hippo, it is very hard even to find a place where there is the slightest chance of catching one, because this brute roams through the forest like an elephant or a pig, mostly goes singly, though sometimes in pairs, and rarely uses the same track twice.

"Meanwhile over a hundred pits had been made by my men, all carefully dug seven feet deep and covered so that not the sharpest eye could detect any sign of danger.

"At last, two days after I shot my first animal, and when I was still working on its thick skin, a boy rushed to my tent breathlessly shouting from afar:

"'Massa! Massa! Dem Mwe done catch!'

"On Nea Tindoa, an inhabited island in the Lofa river, a big bull had fallen into one of my pits. My sergeant, Momoro, started at once with a few boys, to reach the place the same night, and keep guard to prevent the meat-hungry natives from killing the Hippo.

"At last I had succeeded! Against the prophecies of Europeans, Liberians and natives! And only a few days before, Tawe Dadwe told me: 'It is impossible to catch a Mwe![3] It has never been done, and they have only been shot after they have been caught in the pits. They are too dangerous. Many a hunter has been killed. You white men know a lot, but here you are trying something that is impossible.'

ANIMALS EASILY HANDLED.

"Early the next morning I reached the place. Before night a fence had been built around the hole, and the animal was let out. It was a beautiful full-grown bull, in the prime of his life.

"Nothing succeeds like success! Six days after that, the second one was

[3] The native name of the hippopotamus. By English-speaking natives it is usually called the Bush-cow or Bush-pig. It is so different from the larger hippopotamus that some zoologists have created it a distinct genus for it.

caught; this time a two-year-old cow. A week later, the third, a young three-quarter-grown bull was taken."

The difficulties of transport to the coast, and thence to Europe, were great, but the animals stood them well, and apparently are not troubled by small discomforts or bothered by over-sensitive nervous organization. There is every reason to suppose that they would be adapted to semi-domestication in the swamps of the south, unless the supply of food in winter proved too small for their needs. Such a question can only be tested by actual experiment. In case they proved unable to live comfortably on the roots which they could grub up during the colder months, it might be entirely practicable to pen them up and feed them.

As to their hardiness in the open air in the gulf states during winter, there is no evidence, but it need not be presumed that because they come from a tropical country, they could not adapt themselves to the southern United States. Many of the domestic animals in the temperate zone are of strictly tropical origin.

At present the cost of breeding animals is prohibitive, the New York Zoological Society having paid $12,000 for three, but if this difficulty is overcome, animal breeders will have an opportunity to try an experiment that will be as certainly interesting as it will be probably important.

P. B. P.

The Control of Heredity

Natural selection and the survival of the fittest will not of themselves perform miracles of regeneration. They represent the method followed by the workings of heredity. Where the human race is concerned, men have now the power consciously to direct them into barren or profitable channels. The whole fate of civilization hangs on the question of whether this mighty engine of construction or destruction is to be used for good or evil.—W. C. D. and C. D. Whetham: Heredity and Society (1912).

The Influence of Environment

I will not dogmatically assert that environment matters not at all; phases of it may be discovered which produce more effect than any which we have yet been able to deal with. But I think it quite safe to say that the influence of environment is not one-fifth that of heredity, and quite possibly not one-tenth of it. There is no real comparison between nature and nurture; it is essentially the man who makes his environment, and not the environment which makes the man.—Karl Pearson: Nature and Nurture (1910).

PRENATAL INFLUENCES

What We Know of Them Gives No Ground for Making Them a Basis of Eugenic Teaching—Propaganda Must Be Kept on Absolutely Sound Scientific Basis Unless It Is to Result in More Harm Than Good.

DAVID STARR JORDAN,
Chancellor of Leland Stanford Junior University, California.

IT HAS been said that "the transmission of the sacred torch of heredity undimmed to future generations is the most precious of all worths or values in the world."

Accepting this statement from some unknown writer as a substantial fact, we may derive from it the enormous value to the world of all facts which bear on the question of Eugenics, the art by which sound parentage may be granted to the next generation. Every fact relating to human heredity is a precious fact. The aim of the Eugenics movement is to make these facts matters of common knowledge as the multiplication table is. This requires a great deal of time and practice. It is the work of teachers, and its methods should be methods of science, not of emotion.

Because the facts of Eugenics are so incalculably precious, it is necessary that their purity be guarded. To mix up what scientific men really know with what emotional people vaguely guess is to destroy the value of the whole. There are a great many things about heredity and inheritance yet to be discovered. There are many questions to which we do not know the answer until we find it out.

Many of these relate to the relation of external conditions, maternal impressions and the like, to the unborn child. The occasion of writing these lines is the reception of a number of a journal which, with the best of intentions, "holds as chief of the means to be used the power of the parents to determine pre-natally the character of their children."

In other words, it places above actual knowledge of actual fact, a piece of spurious science, partly based on old wives' tales and partly on disconnected facts connected with the wholesomeness of clean living.

"MATERNAL IMPRESSIONS."

What can parents do to determine before birth the character of the child? Nothing, so far as we know, except so to live that the germ cells are not enfeebled, and the foetus checked in its period of quiet nutrition. Most of the stories of prenatal influences are pure fables. No child was ever born with a dog's face, because its mother was scared by a dog. No child ever acquired gift of song, because its mother yearned for music, nor because she saturated her life with melody. The child may be harmed, no doubt, by all kinds of unsanitary life, by hysteria most likely as well as by drugs. But the injury is not rendered in kind—so much liquor, so much tendency to drink—but in reducing as it were the momentum of child life.

The experiments of Dr. Charles R. Stockard and others have shown that germ cells may be actually weakened or destroyed by the use of alcohol. Presumably defective germs would mean defective growth, a matter not of heredity but of development. Apparently many cases of mental and physical distortion have their origin in alcoholic deterioration of germ cells. This line of study opens a large field in which no very great progress has yet been made. It does only mischief to assume that we

know what we only hope or fear that we may sometime know.

There is no question of the transmission of Syphilis from parent to child, for the minute animal organism, Spirochaeta, which produces the disorganization of tissues known as Syphilis, flows with the blood. In like manner, the plant organism, Gonococcus, may be implanted in children, most of those born blind receiving their affliction at birth in the tender membranes of the eyelids.

STORIES INCREDIBLE.

But taking current stories, it is scientifically incredible that Jessie Pomeroy became a murderer because her mother went with the lunch basket to the butcher's shop. How medicines unsuccessfully intended to produce abortion may affect the unborn foetus is a matter about which we know very little and we may condemn the abominable practice itself while admitting that the resultant mischief is beyond our calculation. The "lady," who confessed that the destructive disposition of her little boy was "inherited from her own desperate efforts to rid herself of him before birth," is not a competent judge of the relations of cause and effect. More likely the boy was bad through inheritance of traits of a bad mother, and we have no right to assume that it was her vicious action, not her vicious temper, that left their stamp on the boy's heredity. But it is still more likely that the story itself is a pious invention, told for the sake of the moral it teaches.

It is asserted, in connection with this story, that "common people are kept in ignorance of the causes which produce human monsters." Learned men are also often ignorant in these matters, until little by little they slowly find out the truth, and this truth in general is, "Like the Seed is the Harvest." Clean, wholesome men and women lead clean and wholesome lives. Such people create children from sound and potent germ cells, and to foster this condition is the function of eugenics. Lapses from sound living are usually traits of people of unsound character. Unwholesome traits exist in everyone, and sometimes these are transmitted or exaggerated in the children.

A MODIFICATION FOR WORSE.

A child is a mosaic of parental and atavistic traits, one fourth, on the average, from each parent, others from characters latent in the parent but going farther back. We know of no way by which we can foretell the combination or modify it for the better by any line of action. We may modify it for the worse by intemperance, worry, disease and in ways which prevent normal development or normal nutrition.

To have really good children, the parents must be of good stock themselves. Bad fruit is borne mainly by bad trees, and the inheritance of badness springs from inherent tendencies or perversities, just as strong in heredity where they are latent as where they have been actually called into action. It must not be forgotten that strong characters are not those without temptation to evil, but those in which the better elements are triumphant.

Besides the myths of prenatal influence, we have also a series of myths, more scientific in aspect, but equally unfounded, under the name of Telegony. The first mate of a female animal is supposed under this theory to affect or infect all her future progeny. This idea is probably without any scientific foundation either in man or beasts. It is based on a misinterpretation of a single experiment. A mare once mated to a zebra, bore afterwards to a horse father a colt with traces of dark bars or stripes. But such bars occur among horses not suspected of zebra parentage. The original horse as a wild animal was probably marked by dark stripes. In the little Journal which suggested these remarks, we read, "Ignorance is a fruitful source of wrong in matters of sex, hence the importance of pure knowledge for all." This is all well stated. It needs the further insistence that *no knowledge is pure unless it is true*, and to be true it must be free from all guess work, sentimentalism or hysteria.

VARIATION IN TOBACCO

Change of Environment Seems not to Cause Breaking Up of Types—Crossing the Only Means of Producing New Types—For Commercial Breeding, However, Both Heredity and Environment Must Be Taken into Consideration.

H. K. Hayes
Plant Breeder, Connecticut Agricultural Experiment Station, New Haven, Conn.

In recent years many foreign types of tobacco have been grown from imported seed in the United States. In most cases these have proved very variable in their characters during the early years of their development, and this has led to a common belief that a breaking up of type is caused by the change of environment when seed of southern tobacco is grown in the north.

Shamel[1], in a brief review of some of the phases of tobacco breeding work, says: "The writer believes that the two efficient means of inducing variability as a source of new types are change of environment and crossing. So far as the writer is concerned the change of environment—usually the growing of southern seed in the north—is the most effective means of inducing variability."

A recent article by Hasselbring[2] on Cuban tobaccos gives a logical reason for the diversity of types which are found when Cuban seed is grown in the United States. This writer shows that there are many types of tobacco in Cuba. As the seed is saved from suckers which grow from the base of the old roots and as these suckers do not show the characteristics of the parent plants, no attempts at seed selection have been made. Furthermore, as the seedlings are generally grown in the mountains and sold to growers in all parts of the island this diversity of types is constantly maintained.

Hasselbring also presents data on a number of pure lines which were grown both in Cuba and in Michigan, and shows that in these pure lines no breaking up of type occurred and that whatever modifications did appear due to the change of environment, appeared alike in all of the plants of a given strain.

In 1908 the writer became interested in the study of heredity in tobacco and has had many opportunities to observe the effects of environment on tobacco characters. The results of these observations serve to corroborate the belief that environment does not cause a breaking up of type.

CUBAN VARIETIES USED.

In 1910 an experiment was begun to determine how many years of selection were necessary to develop a type similar to the present Cuban shade variety. During this season about one hundred and fifty plants were grown at the Windsor Tobacco Growers' Corporation in Bloomfield from seed sent from Cuba to the plantation manager, J. B. Stewart. This original seed was given a selection number, 13. The variability this first year was very large and only five or six of the one hundred and fifty plants gave promise of commercial value. Selfed

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[1] Shamel, A. D. Tobacco Breeding Amer. Breeders Report, Vol. 6: 268-275, 1910.

[2] Hasselbring, H. Types of Cuban Tobbacco. The Botanical Gazette, Vol. 53: 113-126, 1912.

CONNECTICUT HAVANA TOBACCO.

On the theory that a change of environment causes variation, Cuban tobacco grown from seed in Connecticut should show wide diversity. A carefully controlled test, however, convinces Mr. Hayes that the supposed variation does not appear, except as it may be the outcome of the mechanical and germinal mixture of characters. When the seeds from a single Cuban plant were sown in Connecticut, the row cultures had a very uniform growth, and the number of leaves was comparatively constant. (Figure 17.)

SUCCESSFUL PLANT BREEDING.

In order to produce a new strain of tobacco, the Connecticut Experiment Station crossed the Cuban Havana type, which has very large leaves but only a few of them, with the Sumatra type, which has numerous leaves, but only small ones. The offspring of this cross showed the characteristics of both parents in a blend, but in the following, or second filial (F_2) generation, the characters segregated, in accordance with the usual Mendelian procedure, so that some of the plants looked like the Havana grandparent and others like the Sumatra grandparent, as is shown in the other photographs illustrating this article. Among the forms produced by the cross were several that approximated the desired result, one of which is shown in figure 20. In the above illustration is the final result—the sought-for variety, which has been given the name of "Halladay Havana." It retains the large size of leaf of the Cuban Havana type to a marked degree, but, thanks to the infusion of Sumatra "blood" has more leaves than the Havana. Two distinct types of this variety are recognized, as shown in the above photograph, the one at the left bearing smooth, drooping leaves, and the one at the right erect, crinkly leaves. The photographs do not accurately represent the number of leaves borne by this new variety, however, for the reason that a first picking of five or six leaves has already been made from each one. (Figure 18.)

seed was saved from the two most desirable plants, which bore 19 and 20 leaves respectively. As a measure of variability the number of leaves per plant was noted and observations on general plant habit were also made. The two selfed plants were given the selection numbers 13-2 and 13-1, and their progeny was grown in 1911.

The variability was also large in the second season, 13-1 being as variable for leaf number as in the first year, but there was a much larger percentage of plants with good-sized leaves than in the original lot. In 13-2 there was a much larger percentage of desirable plants. Two plants of strain 13-2, bearing 18 and 19 leaves respectively, were self-fertiiized and grown the following season. The plants in this third season proved very uniform both in the number and shape of leaves. As far as field characters go, these selections were the equal of the commercial Cuban tobaccos grown on the same field. The quality of the cured leaf was also very good, but no better than the present Connecticut Cuban shade variety.

Much variation was shown in the statistical results for number of leaves per plant. It is this variation that has caused the belief in the efficacy of environment as a means of inducing a breaking up in type. More recent knowledge of heredity convinces us that the apprent breaking up of type is simply an expression of the mechanical and germinal mixture of characters. Selection and inbreeding tend to produce homozygous forms, and the length of time necessary to obtain pure forms is largely dependent on the number of row cultures which may be grown,

CAREFUL TEST MADE.

To determine whether the variations observed in generations of the above experiment had a connection with change of environment, three seed pods picked from different plants growing in Cuba were carefully harvested and sent in separate compartments of a package from Cuba to Mr. Stewart. The seed from each pod was sown in sterilized soil, the seedlings being marked respectively C1, C2 and C3. A row of each of the selections was grown on the same land as the selections 13-2-3 and 13-2-4 previously mentioned.

Each of the row cultures had a very uniform habit of growth. C1 and C3 grew to about the same height, but the average size of leaves of C3 was somewhat larger than for C1. C2 had about the same average size of leaf as C3.

An examination of the results shows that C1 and C3 both produced about 21.3 leaves per plant and were not very variable for leaf number. It is possible that one 13-leaved plant of C3 really belonged to C2 and was accidentally mixed when sown. C2 only gave an average mean of 13.83 leaves per plant and a range of variation from 11 to 18 leaves. These selections show about the same variability, as determined by S. D. and C. V., as 13-2-3, 13-2-4 and the commercial Cuban, and indicate that there has been no breaking up of type due to changed environment.

In connection with a study of inheritance of separate characters of tobacco, some observations have been made on the effect of changed environmental conditions. While all quantitative characters are greatly dependent on environment for their full development, some characters are more noticeably affected than others. The most uniform character of all was found to be the number of leaves per plant. Each of four selections was grown both at Forest Hills, Mass., Bloomfield, Conn., and New Haven, Conn., from seeds of a single plant.

In order to have the counts as uniform as possible and yet allow the crop to be harvested, the following method was used. The number of leaves per plant was counted from the fourth leaf from the bottom to the leaf below the bald sucker at the top, "bald sucker" being the farm name for the first sucker which appears without true leaves. This method allowed the selections to be topped and also gave added interest, as the leaf counts represented about the average number of leaves which were harvested.

The field at Forest Hills was very fertile but in a region where tobacco

GRANDPARENT AND GRANDCHILD.

The Imported Sumatra type (shown at the left) was crossed with the markedly different Havana type (shown in the preceding cut). In the first generation there was a general blending of characters, which segregated in the second generation, so that a wide diversity of types resulted. The plant shown at the right is one of this second generation of the hybrid, in which the characters of the Imported Sumatra have so completely excluded those of the Havana type, that the grandchild can scarcely be distinguished from the pure Sumatra which was one of its grandparents. (Figure 19.)

SECOND GENERATION FROM CROSS.

This is another specimen of the second generation cross between Connecticut Havana and Imported Sumatra. It bore 30 leaves with short internodes, and was, therefore, a close approximation to the desired result, combining the large number of leaves of the Sumatra type with the large size of leaves of the Havana variety. Its contrast with the plant shown in the preceding plate, however, vividly shows the wide diversity of forms produced when segregation of characters takes place. (Figure 20.)

is never grown commercially. Bloomfield is in the center of the tobacco-growing region and the soil is perfectly adapted to it and heavily fertilized. The soil at New Haven is a poor gravelly loam, only moderately dressed with manure and chemicals.

The means of the different selections compared with the average mean show only a variation of 1.8 leaves per plant, and as only about one hundred and fifty plants were counted the results appear very uniform.

STANDARD DEVIATIONS.

As a measure of variability the standard deviations of the selections were calculated. A consideration of them shows the variation to be very uniform and little, if any, affected by different condition of environment. We may also add that these same selections have now been grown at the three different localities for two later generations without any evidence that environment very strongly modifies the number of leaves per plant.

Some observations have also been made upon the effects of different environments on plant height. Two selections were grown both at Bloomfield and in New Haven from seed of the same self-fertilized plants. These selections were very variable, due to the fact that they represent the second generation of a cross between two varieties. While difference in environment has very strongly modified the heights of plants, a consideration of the Standard Deviation convinces one that such modifications of this character as have appeared appear alike in all plants of a selection.

Although no statistical studies can be given showing the effects of environment on the same selection for leaf area, we have some observations on several pure lines of tobacco varieties grown under cultural conditions different from those under which the varieties are normally grown.

These are pure lines of a Connecticut Havana type grown under shade, of a small-leaved Sumatra type grown in the open, and a Broadleaf type grown on a poor sandy soil. By means of a planimeter the area of the bottom, middle and top leaves of one hundred and fifty plants of each of these pure lines was taken. Of course, the area of leaf is a character which is greatly modified by cultural and environmental conditions. The results, however, show about the same variability for the three pure lines given. Observations of these pure lines when growing showed no variation which could be considered as a breaking up of type.

VARIATION DUE TO CROSSING.

The study of the heredity of separate characters of tobacco shows that such characters as shape and size of leaf, size of stalk, and leaf number are in a large measure inherited independently. In brief, the results show that the first generation of a cross between two pure lines is of an intermediate nature in those characters by which the parents differ. In the second generation there is a segregation and recombination of characters and often new forms are produced. Some of the second generation forms breed true in the third generation, others breed true for some characters and are variable in the remainder, and others are as variable as the second generation itself. The length of time which it takes to produce a uniform type will depend largely on the number of varieties which can be grown in F2 and the number of row tests which can be grown in F3.

The general conclusions from this work are that environment is of great importance in any system of tobacco breeding, and quantitative characters and especially quality of cured leaf are in a large measure dependent on this feature. Change of environment, however, does not cause a breaking up of type, and whatever variations occur due to environment appear alike in all plants of a particular type.

Heredity is the second important factor, and poor types will give unfavorable results even under the best environmental conditions. Any system of tobacco breeding must take both heredity and environment into account.

The only known means of producing variability as a source of new types is by crossing. The number of new forms which will appear due to a particular cross will depend on the number of germinal characters by which the parent plants differ.